ASTRONAUTICS AND SPACE EXPLORATION

1661

HEARINGS

BEFORE THE

SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION

EIGHTY-FIFTH CONGRESS

SECOND SESSION

ON

H. R. 11881

APRIL 15, 16, 17, 18, 21, 22, 23, 24, 25, 28, 29, 30, MAY 1, 5, 7, 8, AND 12, 1958

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SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION

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[1] The permanent assignments of the chairman and the other members of the above committee will be found on p VIII.

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ASTRONAUTICS AND SPACE EXPLORATION

TUESDAY, APRIL 15, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS
AND SPACE EXPLORATION,
Washington, D. C.

The committee met at 10 a. m., pursuant to notice, in the caucus room, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack, Brooks, Hays, O'Brien, Natcher, Sisk, Arends, McDonough, Fulton, Keating, and Ford.

Present Also: George J. Feldman, Director and chief counsel

The CHAIRMAN. The committee will be in order.

This is the first public hearing of our committee. Its purpose has been set forth by the House:

> To conduct a thorough and complete study and investigation with respect to all aspects and problems relating to the exploration of outer space and the control, development, and use of astronautical resources, personnel, equipment, and facilities.

We plan to conduct these hearings openly. The scope and detail of their disclosures will be limited only by actual questions of national security. To work in any other way would do a disservice to the country. The problems that face the Congress and the Nation in matters of outer space development are so immense and so critical that they must have the help of an informed public opinion.

In space exploration, and the scientific breakthrough it implies, we are beginning an era of discovery literally as far-reaching as the discovery of our own continent. It is necessary that each broad step in this discovery be made with the American people being as fully informed as possible.

An urgent task of this committee and of the Congress is to enact effective legislation to meet this problem. President Eisenhower has sent a message to the Congress in which he summarized many of the problems and functions that this new organization would handle. He has proposed a National Aeronautics and Space Agency for this task and I have introduced his proposal as H. R. 11881. I am sure the committee will give full thought to this proposal in working out a bill to serve best the purposes which the President set forth.

We cannot overstress the importance of immediate action in the field of space exploration. We must enact legislation for the immediate future and must also lay the groundwork for a long-term effort of exploration and scientific development.

The immediate problem is obvious. We see another nation of great potentiality, militant and competitive, which has already made

the first advances in the mastery of outer space. We cannot stand by and watch this nation make that mastery complete. As Lt. Gen. James M. Gavin, the Army's recently retired Chief of Research put it:

> If they—

that is, the Russians—

> surpass us in technology in the years ahead, there is little doubt who will determine the future of the world

As we make this emergency effort, we must remember it is only the first step in a continuing program of outer-space development, a development which will open new horizons with each unfolding discovery. When the atomic bomb was first exploded, even the men who created it had little idea of the tremendous advances in peacetime development which nuclear power would bring. The use of radioactive isotopes alone has saved American industry millions of dollars a year. In atomic power, the world is finding a great new source of energy. In medicine its value becomes increasingly clear. Thus, despite the specter of nuclear warfare, we begin to see that this new device of science can be made a great force for peace.

With the exploration of outer space, we run into the same huge problems and the same tremendous potential. Our scientists now know the value of space exploration for predicting the weather and, in the end, controlling it. It is difficult to imagine the great and beneficent revolution this would make in farming, in industry, and our daily lives. We have heard also of the value to communications and to our transportation systems that may arise out of this new medium.

What else space holds for us is beyond the threshhold. What we will learn from the moon, and probably the other planets, no man can rightly say. On the basis of what we already know, we can predict that the advances will be literally beyond our present understanding They are giving this country a new frontier. I need not remind you how our American democracy grew great on the older, limited frontiers of the past. The worlds of outer space are the greatest challenge to dynamic thought and deed that our pioneer spirit has ever received.

The stakes are tremendous.

We have many questions before us. Shall the new Agency be controlled by military men or by civilians? Can a civilian organization look after military needs as well? How big—and how limited—will be the new Agency's jurisdiction? Will it act on space problems alone?

Through all these considerations we must also continually balance two things: the immediate emergency needs—the long-range possibilities and their cost. We must also look at the other dark side of the coin. What would Soviet ascendancy in this field mean, to our safety, if not our existence as a Nation?

These are some of the questions which we hope to clarify during our hearings. In keeping with the urgency of this investigation, we are calling no witness who is not absolutely essential to it. Since the first advances in space exploration were made under the direction of the military, our witnesses will include some of those who have been most intimately concerned with the present space plans. Other witnesses will represent broader civilian and scientific aspects of outer space and astronautics.

Without objection, the message of President Eisenhower will be made a part of the record.

Also, without objection, the bill as submitted by the Bureau of the Budget and introduced by myself, will be made a part of the record.

I understand maybe 1 or 2 other Members may have introduced the same bill. If so, we will incorporate that fact into the record.

Without objection, a memorandum prepared for me on March 7, 1958, by Mrs. Eilene Galloway, National Defense analyst of the Foreign Affairs Division of the Legislative Reference Service of the Library of Congress will be made a part of the record.

It is a very interesting memorandum, copies of which, I understand, have been sent to each member of the committee.

Is that correct, Mr. Feldman?

Mr. FELDMAN. Yes, it is.

(The material referred to follows:)

[H. Doc No 365, 85th Cong, 2d sess]

MESSAGE FROM THE PRESIDENT OF THE UNITED STATES RELATIVE TO SPACE SCIENCE AND EXPLORATION

To the Congress of the United States:

Recent developments in long-range rockets for military purposes have for the first time provided man with new machinery so powerful that it can put satellites into orbit, and eventually provide the means for space exploration. The United States of America and the Union of Soviet Socialist Republics have already successfully placed in orbit a number of earth satellites. In fact, it is now within the means of any technologically advanced nation to embark upon practicable programs for exploring outer space The early enactment of appropriate legislation will help assure that the United States takes full advantage of the knowledge of its scientists, the skill of its engineers and technicians, and the resourcefulness of its industry in meeting the challenges of the space age.

During the past several months my Special Assistant for Science and Technology and the President's Science Advisory Committee, of which he is the Chairman, have been conducting a study of the purposes to be served by a national space program, of the types of projects which will be involved, and of the problems of organizing for space science functions. In a statement which I released on March 26, 1958, the Science Advisory Committee has listed four factors which in its judgment give urgency and inevitability to advancement in space technology. These factors are (1) the compelling urge of man to explore the unknown; (2) the need to assure that full advantage is taken of the military potential of space; (3) the effect on national prestige of accomplishment in space science and exploration; and (4) the opportunities for scientific observation and experimentation which will add to our knowledge of the earth, the solar system, and the universe.

These factors have such a direct bearing on the future progress as well as on the security of our Nation that an imaginative and well-conceived space program must be given high priority and a sound organization provided to carry it out. Such a program and the organization which I recommend should contribute to (1) the expansion of human knowledge of outer space and the use of space technology for scientific inquiry, (2) the improvement of the usefulness and efficiency of aircraft, (3) the development of vehicles capable of carrying instruments, equipment, and living organisms into space, (4) the preservation of the role of the United States as a leader in aeronautical and space science and technology, (5) the making available of discoveries of military value to agencies directly concerned with national security, (6) the promotion of cooperation with other nations in space science and technology, and (7) assuring the most effective utilization of the scientific and engineering resources of the United States and the avoidance of duplication of facilities and equipment.

I recommend that aeronautical and space science activities sponsored by the United States be conducted under the direction of a civilian agency, except for those projects primarily associated with military requirements. I have reached this conclusion because space exploration holds promise of adding importantly to our knowledge of the earth, the solar system, and the universe, and because it

is of great importance to have the fullest cooperation of the scientific community at home and abroad in moving forward in the fields of space science and technology. Moreover, a civilian setting for the administration of space function will emphasize the concern of our Nation that outer space be devoted to peaceful and scientific purposes

I am, therefore, recommending that the responsibility for administering the civilian space science and exploration program be lodged in a new National Aeronautics and Space Agency, into which the National Advisory Committee for Aeronautics would be absorbed. Hence, in addition to directing the Nation's civilian space program, the new Agency would continue to perform the important aeronautical research functions presently carried on by the National Advisory Committee for Aeronautics The new Agency would be headed by a Director appointed by the President by and with the advice and consent of the Senate.

In order to assist the President and the Director of the National Aeronautics and Space Agency, I recommend that a National Aeronautics and Space Board, appointed by the President, be created. Several of the members of the Board should be from the Government agencies with the most direct interest in aeronautics, space science, and space technology To assure that military factors are considered by the Board, at least one member should be appointed from the Department of Defense. Members appointed from outside the Government should be eminent in science, engineering, technology, education, or public affairs, and be selected solely because they have established records of distinguished achievement.

The National Aeronautics and Space Agency should be given that authority which it will need to administer successfully the new programs under conditions that cannot now be fully foreseen

In order that the Agency may attract and retain the services of scientists and technicians which it must have to carry out its responsibilities with full effectiveness, it should have the authority, subject to regulations prescribed by the President, to fix the compensation of its employees at rates reasonably competitive with those paid by other employers for comparable work without regard to the provisions of existing classification laws

The Agency should have the power to conduct research projects in its own facilities or by contract with other qualified organizations It will thus be free to enlist the skills and resources required for the space program wherever they may be found, and to do so under the arrangements most satisfactory to all concerned Provision should also be made for continuing and further enhancing the close and effective cooperation with the military departments which has characterized the work of the National Advisory Committee for Aeronautics. Under such cooperative arrangements it is expected that the National Aeronautics and Space Agency will perform research required in the furtherance of strictly military aeronautics and space objectives, just as the National Advisory Committee for Aeronautics now carries on important research work for the military services in aerodynamics, propulsion, materials and other fields important to the development of military aircraft and missiles

The National Advisory Committee for Aeronautics is already engaged in research directly related to flight outside the earth's atmosphere and has research facilities adapted to work in space science Upon the enactment of legislation carrying out my recommendations, all of the resources of the National Advisory Committee for Aeronautics would immediately come under the direction of the new Agency. The Department of Defense and its contractors, as well as other agencies, have active programs which should be considered for administration by the National Aeronautics and Space Agency I recommend that this fact be taken into account and provision made for the transfer to the Agency of such functions, activities, and facilities of other departments and agencies as may be found to be appropriate for administration by the new Agency, subject to the concurrence of the heads of the affected agencies and with the approval of the President.

The Director of the Bureau of the Budget is transmitting to the Congress draft legislation to establish the National Aeronautics and Space Agency and to authorize research into the problems of flight within and outside the earth's atmosphere. I urge that the Congress give prompt consideration to the draft legislation and that it be enacted at the earliest possible date

Pending enactment of legislation, it is essential that necessary work relating to space programs be continued without loss of momentum. For this reason, I have approved, as part of an interim program of space technology and exploration, the launching of a number of unmanned space vehicles under the direction of the

Advanced Research Projects Agency of the Department of Defense. The projects which I have approved include both scientific earth satellites and programs to explore space. In taking this interim action, I directed the Department of Defense to coordinate these projects with the National Advisory Committee for Aeronautics, the National Science Foundation, and the National Academy of Sciences. I also indicated that when a civilian space agency is created, these projects would be reviewed to determine which should continue under the direction of the Department of Defense and which should be placed under the new Agency.

It is also important that measures be taken to assure the prompt and orderly implementation of the proposed aeronautics and space legislation when enacted I am requesting the Department of Defense and the National Advisory Committee for Aeronautics to review pertinent programs of the Department and to recommend to me those which should be placed under the direction of the new Agency I have also asked that they prepare an operating plan to assure support of the new Agency by organizations, facilities, and other resources of the Department of Defense, either by cooperative arrangements or by transfer to the new Agency.

It is contemplated that the Department of Defense will continue to be responsible for space activities peculiar to or primarily associated with military weapons system or military operations Responsibility for other programs is to be assumed by the new Agency In this connection, I commend to the attention of the Congress the comments of my Science Advisory Committee, in its statement of March 26, 1958, on the military applications of space technology.

I am also asking the National Advisory Committee for Aeronautics to begin immediate preparation of such detailed plans as may be required to prepare for the assumption by the National Aeronautics and Space Agency of the responsibilities contemplated for it. Those plans are to set forth the specific new space programs to be initiated and are to describe the internal organization, management structure, staff, facilities, and funds which will be required. The National Advisory Committee for Aeronautics is to discuss with the National Science Foundation and the National Academy of Sciences the matter of participation by the scientific community in determining the scientific objectives of our space programs. The best scientific judgment available should be utilized. Matters related to dissemination of the data collected should also be considered

I have also instructed the National Advisory Committee for Aeronautics to assume the responsibility for preparing and presenting to the appropriate committees of the Congress a full explanation of the proposed legislation and its objectives

The vigorous program contemplated will depend not only on adequate legislative authority but also on adequate financial support. I shall shortly submit to the Congress an amendment to the fiscal year 1959 budget to provide funds that will be needed by the new Agency in its first year of operation.

DWIGHT D. EISENHOWER.

THE WHITE HOUSE,
April 2, 1958

THE PROBLEMS OF CONGRESS IN FORMULATING OUTER-SPACE LEGISLATION

Prepared at the request of, and according to instructions from, the Honorable John W. McCormack, Chairman, Select Committee on Astronautics and Space Exploration, House of Representatives, by Mrs Eilene Galloway, National Defense Analyst, Foreign Affairs Division, the Library of Congress, March 7, 1958

I. THE NEW FRONTIER

The successful launching of an earth satellite by the Russians on October 4, shortly followed by a second and much heavier "sputnik" on November 3, 1957, was a dramatic announcement to the world of scientific progress which opened up new realms for man's exploration of outer space While the United States was caught unawares by this evidence of Soviet mastery of science and technology, it was not far behind in sending its Explorer into orbit on January 31, 1958.

The repercussions of this situation upon the Congress can only be understood in the context of the extreme complexity of outer-space exploration and control. A basic knowledge of science and technology is required in order to determine the relationship of outer-space development to national and international law, national defense, foreign relations, education, communications, and navigation,

weather control, medical research, and the organization and administration of the Government for handling such a combination of subjects. The scientific facts which can be established at the present time, supplemented by our constant increase in knowledge and experience, are essential to the determination of what is feasible and what is impracticable; of those aspects of outer space which can be adequately covered by a national law and those which will require international cooperative arrangements.

From the outset it was apparent that a breakdown of the total subject of outer space into its component parts resulted in specialized topics which cut across the jurisdictional lines of many committees of the Congress. It was not possible to refer bills concerned with outer-space development to one authorizing committee and one appropriations subcommittee for determination. A few hypothetical examples may serve to illustrate both the complexity of the subject and the problem of committee jurisdiction

The Committees on Agriculture would be interested in new methods of weather control which might be accomplished from outer space. The Committees on Armed Services would expect to consider satellites and their connection with long-range ballistic missiles, particularly propulsion systems and problems of reentry into the atmosphere. The House Education and Labor Committee and the Senate Committee on Labor and Public Welfare would have a vital concern with the education of future scientists, laboratory facilities, and grants-in-aid. The Committee son Foreign Affairs and Foreign Relations would expect to consider proposals for the international control of space, international space law and its effects upon national sovereignty and existing treaties and agreements. The Government Operations Committees might wish to study background information which bore on the various problems of their subcommittees The House Interstate and Foreign Commerce Committee has already issued a report on the International Geophysical Year as it pertains to the Arctic and Antarctica, and both House and Senate committes could be expected to have a continuing interest in outer-space projects which affected their jurisdiction over civil aviation, communications, weather, and science. Conceivably the Public Works Committees might consider nonmilitary installations, and the Post Office and Civil Service Committees would be interested in proposals for mail delivery by rockets. A number of subcommittees of the Appropriations Committees would receive authorizations, possibly creating the problem of coordination by the full committees. The Joint Committee on Atomic Energy would be concerned with warheads for outer-space weapons, propulsion devices, the reentry problem, arrangements for sharing information with our allies, and any peaceful uses which required atomic energy as a fuel.

The fact that many committees would have a vital concern with various aspects of outer space is only part of the problem. As such, it raises the question of whether we could expect the sum of the parts to result in a total national effort without some form of congressional coordination. But the greatest complication arises when we consider that one segment of the total outer-space problem may be of primary interest to several committees simultaneously. For example, weather control could come before the Congress in the form of a bill which could be referred to the Committees on Agriculture, Armed Services, Foreign Affairs, Foreign Relations, Interstate and Foreign Commerce; and if the proposed type of weather control involved the use of atomic energy, the matter could also come within the jurisdiction of the Joint Committee on Atomic Energy.

II. HOW CONGRESS MOVED OUT ON THIS FRONTIER

On November 27, 1957, the Preparedness Investigating Subcommittee of the Senate Armed Services Committee began its inquiry into satellite and missile programs. Concluding its first series of hearings on January 23, 1958, the chairman, Senator Lyndon B. Johnson, listed 17 principal areas recommended for decisive action in strengthening our national defense Hearings concerned with outer space and related problems were also held by both Appropriations' Committees, the House Armed Services Committee, and the Special Subcommittee on Outer Space Propulsion of the Joint Committee on Atomic Energy

On February 6, 1958, the Senate established a Special Committee on Space and Astronautics which was directed to make a thorough study of "all aspects and problems relating to the exploration of outer space and the control, development, and use of astronautical resources, personnel, equipment, and facilities." The committee report to the Senate is due by June 1, 1958 "or the earliest practical date thereafter, but not later than January 31, 1959, by bill or otherwise. * * *" Senator Lyndon B. Johnson is chairman of the 13-member committee.

On March 5, 1958, the House of Representatives established the Select Committee on Astronautics and Space Exploration composed of 13 members with Hon. John W. McCormack as chairman. This committee is "authorized and directed to conduct a thorough and complete study and investigation with respect to all aspects and problems relating to the exploration of outer space and the control, development, and use of astronautical resources, personnel, equipment, and facilities." The committee report to the House is due by June 1, 1958, or earlier, but not later than January 3, 1959.

To cover the situation in the meantime, the Congress passed Public Law 85-325 which provides in section 7 that—

"The Secretary of Defense or his designee is authorized to engage in such advanced projects essential to the Defense Department's responsibilities in the field of basic and applied research and development which pertain to weapons systems and military requirements as the Secretary of Defense may determine after consultation with the Joint Chiefs of Staff, and for a period of 1 year from the effective date of this act, the Secretary of Defense or his designee is further authorized to engage in such advanced space projects as may be designated by the President."

In passing the supplemental defense appropriation for fiscal 1958, the Congress approved $10 million in transfer authority for advanced research, and on February 7, 1958, the Secretary of Defense established the Advanced Research Project Agency and named Roy W. Johnson as Director (Public Law 85-322) These arrangements make it possible for outer space projects, both military and nonmilitary, to proceed during the time it takes to formulate permanent legislation for the organization of the executive branch and of the Congress in the handling of outer space problems.

Meanwhile, the President has asked that his scientific adviser, Dr. James W. Killian, Jr., make a study of the kind of organization needed for the future development of outer space.

III. COMPARISON AND CONTRAST OF OUTER SPACE AND ATOMIC ENERGY AS A LEGISLATIVE PROBLEM

The task of the House and Senate committees in formulating outer space legislation has been compared to that of the McMahon committee which held hearings and drew up the original Atomic Energy Act of 1946 An analysis of the similarities and differences of these two subjects may provide guidance in our approach to outer space at the present time.

Atomic energy and outer space are alike in opening new frontiers which are indissolubly linked with the question of war and peace. They combine the possibility of peaceful uses for the benefit of man and of military uses which can destroy civilization. Both are national and international in their scope They involve the relation of science and government, the issue of civilian or military control, and problems of organization for the executive branch and the Congress. If only their similarities are considered, the legislative task would appear to be the easy one of following the pattern of our present atomic energy legislation.

When the differences between atomic energy and outer space are analyzed, however, it becomes apparent that the present assignment is far more complicated than that which confronted the Congress in 1946. As a source of great power derived from a mineral, uranium, atomic energy can be easily defined and its source can be controlled, its use licensed or prohibited, and there is no legal difficulty in devising penalties against its misuse in a national law. Outer space, on the other hand, is comparable to an unexplored geographic area which is unmapped as far as legal definitions are concerned. We cannot control, license, or prohibit the use of outer space by other nations, and thus there are large areas of the subject which are not amenable to a Federal law. It follows, therefore, that one of the unique tasks of the committee will be to determine the line between those aspects of outer space which can be governed by the United States and those which will require international cooperation. In order to do this it will be necessary first to assemble the scientific facts and to arrive at definitions of outer space which will be acceptable not only within the United States but within the international community of nations Unless this is done, there is the like hood that our national law may contain provisions which might prevent us at some later time from participating in some form of international control.

The line between the peaceful and military uses of outer space is much more difficult to draw than is the case with atomic energy. There are peaceful uses of atomic energy which obviously have no military application, e. g., radioisotope

research in various forms, particularly cancer research. Practically every peaceful use of outer space appears to have a military application. For example, the Military Establishment is concerned with weather control, all forms of communication, reconnaissance satellites for mapping; and, even medical research on weightlessness has implications for satellite weapons. Thus it is possible for a nation to send up a peaceful satellite for scientific purposes and to be accused—justly or unjustly—of engaging in this activity for military purposes. If a study of the scientific facts of outer space leads to the conclusion that most if not all exploration yields knowledge which can be used for military purposes by any nation engaged in such activity, then civilian control may be an answer to only part of the total problem. We can establish civilian control within the United States, but if it turns out that peaceful uses cannot be scientifically separated from military implications, then how are we to regulate the international civilian-military situation? Here, again, it will be necessary to ask the scientists precisely how outer space can be controlled for the benefit of mankind and what projects can be devised which will have worldwide acceptance as being peaceful in their nature.

At least one difference between atomic energy and outer space is an advantage rather than a complication. The first use of atomic energy was in the form of bombs used during a war, the first use of earth satellites has been for peaceful purposes. Satellites have not progressed to the point where they are weapons even though their launching devices may be the same as those used for IRBM's and ICBM's. There are 64 nations cooperating in the studies inaugurated by the International Geophysical Year, and since this worldwide effort was started by the scientists themselves, there is room for hope that at least some parts of the IGY program can be continued into the future. Perhaps the scientists and the political scientists will be able to make proposals which will provide for the coordination of national legislation with international arrangements. If some effort is not made along this line, there is danger that this gain in international cooperation may be dissipated.

The existing situation and the time element with which the House and Senate Committees on outer space have to contend is more difficult than that faced by the committee which investigated atomic energy in 1946. At that time the war was at an end, the United States had a monopoly on atomic energy and it was possible to take time to formulate legislation without feeling that meanwhile the situation might get out of hand. No other nation was then engaged in atomic energy development as advanced as that of the present satellite program of the Soviet Union. Atomic energy information could be classified whereas data on satellites is being shared by agreement among the nations participating in the International Geophysical Year.

Furthermore, the atomic energy program within the United States was easier to deal with in 1946 than is the case with outer space in 1958. Atomic energy had been developed by 1 military departmant and was headed by 1 man, whereas outer-space programs are now actively under in 3 military departments where they have been subjected to a plethora of committees. We now have one director for guided missiles and another for antimissile missiles and satellites. The personnel and facilities for outer-space projects are widely dispersed, and the first nonmilitary development of earth satellites has been the responsibility of military departments. If the people who know how to produce outer-space vehicles are not located in the military departments, they are largely employed by business firms or universities operating under contracts from the Army, the Navy, or the Air Force. It will be a difficult legislative task to devise a law for the effective organization and administration of these far-flung operations in which the military and non-military are so closely associated.

IV. LEGISLATIVE PROPOSALS AND ISSUES

Several bills providing for outer-space development have already been introduced in the Congress, and these combined with the present arrangement whereby both military and nonmilitary programs are the responsibility of the Department of Defense, provide 5 alternative methods for the organization of the executive branch and at least 3 for the Congress. Additional proposals may be made in the future, but at the present time it is possible to see the large outlines of emerging patterns.

A. Alternative proposals for organization of the executive branch

1. *Development of outer space by the Department of Defense*.—Thus far the United States satellite programs have been conducted within the Department of Defense

and will continue there until the Congress makes different arrangements than those now established for the Advanced Research Projects Agency The fact that this Agency was given responsibility only until February 12, 1959, for engaging in nonmilitary advanced space projects designated by the President suggests that the Congress considered this to be a temporary arrangement to take care of the situation pending further study of the matter The personnel, resources, and facilities for outer-space projects are now located within the Department of Defense, and within the Army, the Navy, and the Air Force, there are teams of people who are already organized to achieve certain objectives For this reason it may be expected that the advantages and disadvantages of removing outer space from the Pentagon will be strongly presented

Since the President has already expressed his approval of civilian control of outer-space programs for scientific purposes, and since the Congress has presumably left nonmilitary projects in the Pentagon as a temporary expedient, it seems likely that the main concern will be with the following questions

(1) Upon the basis of what scientific facts can a line be drawn between military and nonmilitary outer-space projects?

(2) What effective arrangements can be made by a civilian agency for meeting the military requirements of the Department of Defense?

(3) Will the same launching devices be used for military and nonmilitary satellites or will a new civilian agency develop its own equipment?

(4) How shall we divide the limited personnel and existing facilities for outer-space development between the Pentagon and a new civilian agency?

2. *Development of outer space by the Atomic Energy Commission.*—This proposal would amend the Atomic Energy Act of 1954 by adding a Division of Outer Space Development to the Atomic Energy Commission Those who favor this proposal point out that the AEC has been operating successfully for some years in a scientific field which combines peaceful and military projects It has been able to meet the requirements of the Department of Defense and to advance the peacetime uses of atomic energy in a variety of ways On the other hand, a question has been raised with regard to the adequacy of the Commission's personnel and facilities for developing outer space Several questions might be explored in order to estimate the probable repercussions of placing outer-space development in the Atomic Energy Commission

(1) Will it not be necessary to arrive at accepted definitions for outer space before placing the subject in a law which legally defines atomic energy? Will all the provisions of the Atomic Energy Act of 1954 be applicable to outer space, and if not, should a determination be made in advance of all the changes in the law which would be necessary for the legal accommodation of outer space?

(2) If it is decided to remove purely scientific outer-space projects from the administration of the Department of Defense, would the transfer of personnel and facilities to the Atomic Energy Commission be any different from their transfer to some other type of civilian agency?

(3) If outer space is not to be administered by the Atomic Energy Commission, how will its work on related nuclear devices be effectively coordinated with the outer-space projects of a new civilian agency?

(4) If outer space is to be administered by the Atomic Energy Commission, would it be desirable to change the name of the Commission to correspond to its new terms of reference?

3 *Development of outer space by a new Commission.*—This proposal would establish a Commission on Outer Space which would be patterned essentially along the lines of the present Atomic Energy Commission. The possible effects of this proposal may be analyzed by raising the following questions:

(1) How would the relationship between the Commission on Outer Space and the present Atomic Energy Commission be worked out?

(2) Is it possible that the two Commissions might duplicate work on launching devices and propellents for long range missiles and satellites?

(3) Would the Department of Defense encounter any administrative difficulties in obtaining nuclear warheads from the Atomic Energy Commission and outer-space vehicles for the delivery of warheads from the Outer Space Commission?

(4) Would it be practicable and scientifically feasible for the Commission on Outer Space to be primarily concerned with peaceful uses while the Department of Defense retained control over the military uses of outer space?

(5) Since outer-space development is closely connected with the conduct of our foreign relations in such a manner as to prevent war, what would be the relationship between the new Commission and the Department of State? (This same question might be asked with regard to each of the five alternative proposals)

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4. *Coordination of the outer-space program by the National Advisory Committee for Aeronautics working with the National Academy of Sciences and the National Science Foundation.*—Under this proposal or some variation of it, planning and priorities would be undertaken by the National Academy of Sciences, appropriations and construction would be the concern of the National Science Foundation, while the NACA would coordinate nonmilitary space projects and work in a liaison capacity with the Advanced Research Projects Agency in the Department of Defense.

Those who advocate outer-space development by the NACA emphasize its contributions to aeronautics during the past 4 decades, the high quality of its leadership, and its production of new research tools, e. g., multistage research rockets and the transonic wind tunnel. Debate on the subject has not shaped up to the point where any disadvantages have been brought to light, and the determination of what would be likely to happen if outer space were given to the NACA would seem to depend upon the evaluation of testimony from expert witnesses. Some of the questions which might be asked are as follows:

(1) Should the total responsibility for outer-space development be located in an agency which is primarily scientific and technical?

(2) How would the executive branch of the Government be organized to deal with outer-space developments which affected the conduct of foreign policy? What would be the relationship between the NACA, the ARPA, the President's scientific adviser, and the Secretary of State?

(3) What agency or official would coordinate our national outer-space effort with proposals for international cooperation? Is it contemplated that the National Security Council will function in this area?

(4) What agency will handle questions of international space law?

(5) Is NACA strongly favored by the scientists as an agency offering the best atmosphere for a working relationship between science and government?

5 *Development of outer space within a Department of Science*—Proposals have been advanced for a Department of Science at the Cabinet level, and if this step were taken, outer space would be one of many subjects which would be referred to the new organization Since this proposal would involve the transfer of scientific activities from practically every department of the Government, its evaluation would necessarily include far more factors than those involved in outer space. An appraisal of how outer-space development might be expected to progress in a Department of Science would require expert testimony on all of the questions which have been listed in this paper.

B. Alternative proposals for organization of the Congress

Proposals have been made for establishing a new Joint Committee on Outer Space and for giving the jurisdiction of outer space to the present Joint Committee on Atomic Energy. It would also be possible to have separate House and Senate committees for dealing with this subject, although this idea does not seem to be "in the wind" at the present time.

The question of whether the Congress can have two joint committees working on such closely related subjects as outer space and atomic energy would seem to require the same type of analysis as that suggested in this paper for the two matching executive commissions.

(1) How closely are the subjects of outer space and atomic energy related?

(2) Would it be possible to have 2 Commissions send almost identical bills to 2 joint committees on such a subject as launching devices for long-range missiles and satellites?

(3) If there were a conflict of jurisdiction over the two joint committees, who would decide the referral of bills?

(4) If congressional jurisdiction over outer space is given to the Joint Committee on Atomic Energy, should the name of that committee be changed in accordance with its expanded terms of reference?

(5) Whether outer space is referred by the Congress to its present Joint Committee, or to a new one, how will the committee work with other congressional committees which have a primary interest in legislation on such subjects as weather control, communications, navigation, education, and national defense?

(6) Could more coordination in the Congress be achieved by having permanent House and Senate standing committees with representative membership similar to that of the present special committees?

[H. R. 11881, 85th Cong., 2d sess.]

A BILL To provide for research into problems of flight within and outside the earth's atmosphere, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Aeronautics and Space Act of 1958".

DECLARATION OF POLICY

SEC. 2. The Congress hereby declares that the general welfare and security of the United States require that adequate provision be made for research into, and the solution of, problems of flight within and outside the earth's atmosphere and that provision also be made for the development, testing, and operation for research purposes of aircraft, missiles, satellites and other space vehicles, manned and unmanned, together with associated equipment and devices. The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States, except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense These activities should be conducted so as to contribute materially to one or more of the following policy objectives: (1) the expansion of human knowledge of phenomena in the atmosphere and space, (2) the improvement of the usefulness, performance, safety, and efficiency of aircraft, (3) the development and operation of vehicles capable of carrying instruments, equipment, and living organisms through space, (4) the preservation of the role of the United States as a leader in aeronautical and space science and technology, (5) the making available to agencies directly concerned with national defense of discoveries that have military value or significance, (6) cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof, and (7) the most effective utilization of the scientific and engineering resources of the United States and the avoidance of duplication of facilities and equipment.

NATIONAL AERONAUTICS AND SPACE AGENCY

SEC. 3. There is hereby established the National Aeronautics and Space Agency, hereinafter called the "Agency". The Agency shall be headed by a Director who shall be appointed by the President by and with the advice and consent of the Senate, shall receive compensation at the rate of $22,500 per annum, and, except as otherwise provided in this Act, shall exercise the functions of the Agency. The Director may from time to time make such provisions as he may deem appropriate authorizing the performance by any officer, employee, or administrative unit under his jurisdiction of any of his functions under this Act.

NATIONAL AERONAUTICS AND SPACE BOARD

SEC. 4. (a) There is hereby established the National Aeronautics and Space Board, hereinafter called the "Board", which shall be composed of not to exceed seventeen members appointed by the President.

(1) No more than eight of the members of the Board shall be designated from appropriate departments or agencies of the Government of the United States, including at least one who shall be from the Department of Defense

(2) Members of the Board other than those appointed under subsection (a) (1) of this section shall be eminent in science, engineering, technology, education, or public affairs and shall be selected solely on the basis of established records of distinguished achievement, and shall be appointed for terms of four years from the date of expiration of the terms of the members whom they succeed, except that in making initial appointments of such members the President may make appointments for such shorter terms as he deems appropriate.

(b) The Chairman of the Board shall be designated from time to time by the President from among the members appointed under subsection (a) (2) of this section. Such members shall be paid travel expenses and per diem in accordance with the provisions relating to persons serving without compensation under section 5 of the Administrative Expenses Act of 1946, as amended (5 U. S. C. 73b–2).

FUNCTIONS OF THE BOARD

SEC. 5. (a) The Board shall meet at least four times each year and shall advise the President and the Director concerning policies and programs of the Agency. The Board shall make an annual report and from time to time such other reports to the President as it deems appropriate

(b) The Board may make recommendations to the President with respect to the appointment of the Director, and the Director shall not be appointed until the Board shall have had a reasonable opportunity to make such recommendations

(c) The Board shall be consulted by the Director prior to—

(1) initiation or substantial modification of policies or programs of the Agency,

(2) transmittal of any request for appropriations to the Bureau of the Budget pursuant to the Budget and Accounting Act, 1921, as amended (31 U S C 1 et seq);

(3) establishment of major constituent organizational units of the Agency, and the assignment of major functions or groups of functions thereto; and

(4) appointment by the Director of the heads of major constituent units.

FUNCTIONS OF THE AGENCY

SEC 6. (a) The Agency shall—

(1) develop a comprehensive program of research in the aeronautical and space sciences;

(2) plan, direct, and conduct scientific studies and investigations of the problems of manned or unmanned flight within or outside the earth's atmosphere with a view to their practical solution,

(3) develop, test, launch, and operate aeronautical and space vehicles;

(4) arrange for participation by the scientific community in planning, scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations, and provide as appropriate for dissemination of data collected, and

(5) submit to the President for transmittal to the Congress an annual report of operations and accomplishments.

(b) In performance of the above functions the Agency is authorizes—

(1) to make, promulgate, issue, rescind, and amend rules and regulations governing the manner of its operations and the exercise of the powers vested in it by law;

(2) subject to the civil service laws, to select, appoint, employ, and subject to such regulations as the President may prescribe and without regard to the Classification Act of 1949, as amended (5 U. S. C 1072 et seq), and the Federal Employees Pay Act of 1945, as amended (5 U S. C. 901 et seq), fix and adjust, as nearly as consistent with the public interest and on the basis of equal pay for equal work at rates which are reasonably comparable with prevailing rates paid by non-Federal employers for similar work, compensation of such officers and employees as may be necessary to carry out the provisions of this Act,

(3) to acquire, construct, improve, repair, operate, and maintain laboratories, research and testing sites and facilities, manned and unmanned aeronautical and space vehicles, quarters and related accommodations for employees and dependents of employees of the Agency, and such other real and personal property, or any interest therein, as the Agency deems necessary within and outside the continental United States, to lease to others such real and personal property; to sell and otherwise dispose of real and personal property in accordance with the provisions of the Federal Property and Administrative Services Act of 1949, as amended (40 U. S. C 471 et seq.), and to provide by contract or otherwise for cafeterias at its installations and to purchase and maintain equipment therefor, the receipts therefrom shall be deposited to a special fund in the Treasury which shall remain available for obligation and expenditure in connection with such operations and purchase and maintenance of equipment,

(4) to accept gifts or donations of services, money, or property, real, personal or mixed, tangible or intangible, and to make grants to further the authorized purposes of the Act,

(5) without regard to section 3648 of the Revised Statutes, as amended (31 U. S. C. 529), to enter into and perform such contracts, leases, cooperative

agreements, or other transactions as may be necessary in the conduct of its work and on such terms as it may deem appropriate, with any agency or instrumentality of the United States, or with any State, Territory, or possession, or with any political subdivision thereof, or with any person, firm, association, corporation, or educational institution,

(6) to use with their consent the services, equipment, personnel, and facilities of Federal and other agencies with or without reimbursement and on a similar basis to cooperate with other public and private agencies and instrumentalities in the use of the services, equipment, and facilities of the Agency. In addition to authority to use provided by this subsection and, notwithstanding any other provision of law, any governmental agency or component thereof is authorized to transfer to the Agency, without reimbursement, supplies, equipment, aircraft, missiles, space vehicles, and related parts other than administrative supplies or equipment,

(7) to appoint such advisory committees as may be appropriate for purposes of consultation and advice to the Agency in performance of its functions,

(8) to obtain services as authorized by section 15 of the Act of August 2, 1946 (5 U. S C. 55a), at rates not to exceed $100 per diem,

(9) when determined by the Director to be necessary and subject to such security investigations as he may determine to be appropriate, to employ aliens without regard to statutory provisions prohibiting payment of compensation to aliens,

(10) to employ and compensate retired commissioned officers of the United States at the rate established for the positions so occupied by them within the Agency, less the amount of their retired pay *Provided*, That, when the retired pay amounts to or exceeds the rate of compensation established for the position occupied, such person shall be entitled to the pay of the Agency position, or the retired pay, whichever he may elect;

(11) with the approval of the President, to enter into cooperative agreements under which members of the Army, Navy, Air Force, and Marine Corps may be detailed by the appropriate Secretary for services in performance of functions under this Act to the same extent to which they might be lawfully assigned in the Department of Defense,

(12) to the extent the Director finds it will contribute to achievement of the objectives of this Act or to the more effective functioning of the Agency, to conduct or provide training and to assign employees to research, study, or training at Federal or non-Federal facilities, including public or private agencies, institutions of learning, laboratories, industrial or commercial organizations, or other appropriate organizations or institutions, foreign or domestic, and, if the Director deems it appropriate, to pay in whole or in part, the following: The salaries of such employees for the periods of such training or assignments: the cost of their transportation and per diem in lieu of subsistence in accordance with the Travel Expenses Act of 1949, as amended (5 U S C 834 et seq), necessary expenses incident to their training or assignment, including tuition, fees, study materials, and other customary expenses The Agency shall require any employee who accepts such a leave or assignment to agree in writing to return to and, unless involuntarily separated therefrom, to remain in the service of the Agency for a period equal to three times the length of any time off with pay granted such employee without charge to annual leave for the purpose of such training or assignment. Any employee who fails to fulfill such agreement shall be required to reimburse the Government for whatever portion the Director determines to be equitable of the transportation, per diem in lieu of subsistence, and other expenses incident to such training or assignment paid by the Government To the extent authorized by the Director, contributions may be made by private sources and accepted by employees receiving training in non-Federal facilities without regard to the provisions of section 1914 of title 18 of the United States Code;

(13) to authorize employees to attend meetings concerned with functions or activities of the Agency including improved conduct, supervision, or management of such functions or activities, and to pay the whole or any part of the expenses of such attendance,

(14) (a) to consider, ascertain, adjust, determine, settle, and pay, on behalf of the United States, any claim for money damage of $5,000 or less against the United States for bodily injury, death, or damage to or loss of real or personal property resulting from the conduct of the Agency's functions as specified in subsections 6 (a) (2), (3), and (4), where such claim is presented to the Agency in writing within two years after the accident or incident out of which the claim arises;

(b) if the Agency considers that a claim in excess of $5,000 is meritorious and would otherwise be covered by this subsection it may pay the claimant $5,000 and report the excess to Congress for its consideration;

(c) except as provided in (b) of this subsection, no claim may be paid under this section unless the amount tendered is accepted by the claimant in full satisfaction.

(15) to arrange with the Civil Service Commission for the conduct of appropriate security or other personnel investigations of employees of the Agency, contractors and subcontractors, and their employees, as the Director deems necessary in the conduct of official functions of the Agency: *Provided*, That in the event an investigation made under this authority develops any data reflecting that the individual who is subject of the investigation is of questionable loyalty, the matter shall be referred to the Federal Bureau of Investigation for the conduct of a full field investigation, the results of which will be furnished to the Agency;

(16) to direct such of its officers and employees as it deems necessary in the public interest to carry firearms while in the conduct of their official duties. The Agency may also authorize such of those employees of its contractors engaged in the protection of property owned by the United States and located at facilities owned by or contracted to the United States, as it deems necessary in the public interest, to carry firearms while in the conduct of their official duties.

SECURITY

SEC. 7. (a) The Atomic Energy Commission may authorize access to Restricted Data by the Atomic Energy prospective contractor, licensee or prospective licensee of the Atomic Energy Commission or any other person authorized access to the Restricted Data by the Atomic Energy Commission under subsection 145 b. of the Atomic Energy Act of 1954, as amended (42 U. S. C. 2163), to permit any member of the Board or an advisory committee, or any officer, employee, contractor, or employee of a contractor of the Agency to have access to Restricted Data required in the performance of his duties and so certified by the Director: *Provided, however*, That the Director or his designee has determined, in accordance with the established personnel security procedures and standards of the Agency, that permitting the member of the Board or an advisory committee, or employee, contractor, or employee of a contractor to have access to such Restricted Data will not endanger the common defense and security: *And provided further*, That the Director finds that the established personnel and other security procedures and standards of the Agency are adequate and in reasonable conformity to the standards established by the Atomic Energy Commission under section 145 of the Atomic Energy Act of 1954, as amended (42 U. S. C. 2165).

(b) Whoever willfully shall violate, attempt to violate, or conspire to violate any regulation or order as shall be promulgated by the Director for the protection or security of any laboratory, station, base or other facility, or part thereof, or any aircraft, missile, spacecraft or similar vehicle existing, or later conceived, or part thereof, or other property or equipment in the custody of the Agency shall be guilty of a misdemeanor and upon conviction thereof shall be liable to a fine of not to exceed $5,000, or to imprisonment of not more than one year, or both, except that whoever commits such an offense with intent to injure the United States or with intent to secure an advantage to any foreign nation, shall, upon conviction thereof be punished by a fine of not more than $20,000 or by imprisonment for not more than twenty years or both.

(c) Section 1114 of title 18, United States Code, is hereby amended by striking our "or any officer or employee of the Indian field service of the United States," and inserting in lieu thereof "any officer or employee of the Indian field service of the United States, or any officer or employee of the National Aeronautics and Space Agency directed to guard and protect property of the United States under administration and control of the National Aeronautics and Space Agency."

TRANSFER OF RELATED FUNCTIONS

SEC. 8. For a period of three years after the effective date of this Act, the Agency, with the concurrence of the head of the department or agency concerned and with the approval of the President, may transfer to itself any functions (in-

cluding powers, duties, activities, facilities, and parts of functions) of such department or agency or of any officer or organizational entity thereof which relate primarily to the functions of the Agency as set forth in section 6 hereof. In connection with any such transfer the President may, under authority of this section or under other applicable authority, provide for appropriate transfers of records, property, civilian personnel, and funds.

APPROPRIATIONS

SEC. 9. (a) There are hereby authorized to be appropriated without fiscal year limitation such sums as may be necessary and appropriate for the carrying out of the provisions and purposes of this Act

(b) Any funds appropriated for the construction of facilities may be used for emergency repairs of existing facilities when such existing facilities are made inoperative by major breakdown, accident, or other circumstances and such repairs are deemed by the Director of the Agency to be of greater urgency than the construction of new facilities.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

SEC. 10. (a) The National Advisory Committee for Aeronautics on the effective date of this Act shall cease to exist as such and all real and personal property, personnel, funds, and records of that organization are hereby transferred to the Agency. The Agency shall wind up any outstanding affairs of the National Advisory Committee for Aeronautics not otherwise provided for in this Act. Except as otherwise directed by the President, the members of the National Advisory Committee for Aeronautics shall serve as the members of the National Aeronautics and Space Board until their successors are appointed by the President as provided in section 4 of this Act.

(b) Section 2302 of title 10 of the United States Code is amended by deleting the phrase "or the Executive Secretary of the National Advisory Committee for Aeronautics." and by inserting in lieu thereof the phrase "or the Director of the National Aeronautics and Space Agency"; and, section 2303 of said title 10 is amended by deleting the phrase "The National Advisory Committee for Aeronautics." and by inserting in lieu thereof the phrase "The National Aeronautics and Space Agency.".

(c) Section 1 of the Act of August 26, 1950 (5 U. S. C. 22–1), is amended by deleting the phrase "National Advisory Committee for Aeronautics" wherever it appears and by inserting in lieu of the deleted words, in each instance, the phrase "National Aeronautics and Space Agency"

(d) The Unitary Wind Tunnel Plan Act of 1949 (50 U. S C 511) is amended by deleting the phrase "The National Advisory Committee for Aeronautics (hereinafter referred to as the 'Committee')" and by inserting in lieu thereof the phrase "The National Aeronautics and Space Agency (hereinafter referred to as the 'Agency')" and is further amended by deleting the word "Committee" wherever it appears and by inserting in lieu thereof, in each instance, the word "Agency"

(H. R. 11882, Mr. Arends, of Illinois; H. R. 11887, Mr. Haskell, of Delaware; H. R. 11888, Mr. Keating, of New York; H. R. 11961, Mr. Frelinghuysen, of New Jersey; and H. R. 11964, Mr. Fulton, of Pennsylvania, are identical with H. R. 11881.)

The CHAIRMAN. This is the opening of the public hearings of the Select Committee on Astronautics and Space Exploration, adopted by the House of Representatives in an amendment and appointed by the Speaker.

We are fortunate in having before us as a first witness a very distinguished gentleman, dedicated to the way of peace and to the preservation of the way of life that free men and free women believe in and want and seek and desire.

I refer to Dr. Wernher von Braun.

We are happy to have you with us, Doctor, and shall be very glad to hear your testimony.

Have you a prepared statement?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. We will be glad to hear it.

STATEMENT OF DR. WERNHER VON BRAUN,[1] DIRECTOR, DEVELOPMENT OPERATIONS DIVISION, ARMY BALLISTIC MISSILE AGENCY, HUNTSVILLE, ALA.

Dr. VON BRAUN. It is a pleasure to appear before you today. I am Director of Technical Development at the Army Ballistic Missile Agency, and as such I am happy to represent our fine team of development engineers and scientists. Let me assure you that our usage of the word "team" is not restricted only to those of us who came to this country from Peenemunde, but now encompasses the many engineers and scientists, both civilian and military, with whom we have joined in the development of the Redstone and Jupiter missiles. After giving you a brief summary of the activities of our team, I will be fully responsive to your questions.

The experience of our team begins in the 1930's in Germany, and includes development of the V–2 missiles of World War II. Since those days our work on ballistic missiles has proceeded at an ever-increasing pace. The V–2 required many years of development before it was successfully fired in 1942; then, 2 more years were required before the V–2 was a useful weapon. Even then it was a crude device when measured against such missiles as Redstone and Jupiter.

Before the end of World War II it became apparent to our group that we must sooner or later choose between capture by the Russian Army and surrender to the American Army. The choice of the majority, as you know, was to surrender to the American Army. That choice has extended to full citizenship for the majority of our group.

We are proud of work in behalf of our country. The Redstone has already proven itself a workhorse missile, readily adaptable to a variety of uses. Jupiter is progressing through its developmental stage at a very satisfactory pace, and promises to duplicate the reliability of the Redstone.

Looking into the future, we believe that it is necessary to recognize the interrelation of ballistic missiles, satellites, and space travel. The basic elements are the same—rocket engines, structures, guidance and control devices, as well as certain ground support facilities. The mastery of space depends on the same resources as the development of ballistic missiles. But this does not mean that it will be a natural and automatic byproduct of the latter. Indeed, the very scope of the exploration of outer space is so vast as simply to preclude its being the byproduct or fallout of anything. We can meet this challenge only if we appreciate and respect the magnitude of this task and discontinue our unfortunate practice of supporting only such research and development that serves immediate military objectives.

The research and development requirements ahead of us are so vast

[1] Von Braun, Wernher, engr , b Wirsitz, Eastern Germany, Mar 23, 1912 s Baron Magnus and Emmy (von Quistorp) Von B , student Inst Tech , Zurich, Switzerland, 1931 B S , Inst Tech , Berlin, Germany, 1932; Ph D , U Berlin, 1934, m Maria Von Quistorp, Mar 1, 1947, 2 daus , Iris, Margrit Came to U S , 1945, received 1st citizenship papers 1950 Asst to Prof Oberth, Mediasch, Roumania, 1930, experimenting with small liquid fuel rocket motors, Berlin-Ploetzensee, founding mem Rocket Field Berlin, small rocket exptl sta , sponsored and financed by German Rocket Soc , 1930, liquid fuel rocket expert German Ordnance Dept , Kummersdorf, 1932–37, tech dir German Rocket Research Center, Peenemuende, Baltic Sea, 1937–45, research prof Peenemuende, 1943–45, responsible for development of V–2 Long Range Rocket and A A. Guided Missile Wasserfall, 1937–45. With U S Dept of Def , Ordnance Dept , as tech adviser to White Sands Proving Grounds, also proj dir Ft Bliss, Tex , 1945–50 Chief Guided Missile Development Division, Redstone Arsenal, Huntsville, Ala , since 1950, specialist in rocket design, rocket controls, development of large liquid fuel rockets and rocket power plants for rocket planes, guided missiles Hon fellow Brit interplanetary Soc , London, fellow Am Rocket Soc ; hon mem Norwegian interplanetary Soc , (Oslo, Norway), Gesselschaft fur Weltraumforschung (Stuttgart and Freidrichstadt, Germany). Author The Mars Project, 1952, co-author Physics and Medicine of the Upper Atmosphere, 1952, Space Medicine, 1952, Across the Space Frontier, 1952; Conquest of the Moon, 1953 Club Explorers (N. Y C) Home 907 McClung St. Office Development Div , Redstone Arsenal, Huntsville, Ala

that there should be no question in anyone's mind about a shortage of workload for any of the qualified development teams. It may be wise to have some overlapping of programs and to instill a bit of competition between teams. However, we must carefully retain the present atmosphere of free and full exchange of information in order to avoid costly duplication of effort and to provide for mutual assistance between teams. Also, our scientists should be free to pursue their efforts without continual worry about a program cancellation putting them out of business and thus destroying the team they have built up. The ABMA record of accomplishment for money spent is full evidence that waste will not occur if the existing well-qualified development teams of the country are kept together and allowed to pursue their goals under competent management in a coordinated program.

The Russians have shown clearly their recognition of the importance of the entire field of rocket-propelled devices leading to space control. They have further shown an understanding of the interrelation between scientific and military programs in the entire field. Vigorous action is required to overcome as quickly as possible the obvious lead which the Russians now enjoy.

Gentlemen, this will not be easy, but it must be done. This has been a very brief opening statement, and I will now be pleased to respond to your questions.

The CHAIRMAN. Doctor, in connection with your last statement about the efforts that must be made to overcome the obvious lead which the Russians now enjoy, can you elaborate upon that?

Dr. VON BRAUN. Sir, I consider the greatest single threat in the Russian position in ballistics missiles and space flight the fact that the momentum of their development effort at this time is evidently greater than ours.

When you look back at the low state of general technology evidenced by Soviet Russia at the end of World War II, and when you consider, in addition to that, the tremendous damage inflicted upon Soviet industry by the war itself, I think nobody can seriously doubt that the Russian rate of progress is faster in the field of advanced technology than ours.

This holds not only for ballistic rockets and guided missiles and satellite vehicles, but also for things like jet aircraft.

The CHAIRMAN. How do you account for their progress being more rapid than ours? We have the brains and we have the facilities?

Dr. VON BRAUN. Sir, I believe the most important single reason lies in the fact that right after the war the Russians did not return to the production of consumer goods whereas this country did. Russia kept her war production machinery going full blast after the war despite the fact that the civilian population of Russia probably would have enjoyed the production of consumer goods at least as much as the people in this country It was all merely a question of emphasis.

The CHAIRMAN. I will have some questions later. Mr. Brooks, do you have any questions to ask?

Mr. BROOKS. No questions.

The CHAIRMAN. Mr. Hays, do you have any questions?

Mr. HAYS. No questions at this time.

The CHAIRMAN. Mr. O'Brien?

Mr. O'BRIEN. I would like to ask one question, Doctor.

We know that the Russians now have no satellite in space. Do

you believe that they are at the moment planning something new and spectacular and beyond what they have already demonstrated?

Dr. VON BRAUN. I am convinced of that; yes, sir.

Mr. O'BRIEN. Thank you.

The CHAIRMAN. Congressman Natcher?

Mr. NATCHER. Doctor, in establishing a national space exploration program, I think it is imperative that we decide what steps and methods are feasible and expedient and what priority must be established for such a program.

In your opinion, Doctor, should this be a "crash" program? How should it start?

Dr. VON BRAUN. Sir, if you mean by a crash program a temporary effort merely to make up for time lost in the past, then I am against a crash program.

If you mean a sustained effort, without any hot and cold blowing, but sustained and adequately supported over a period of 10 or 15 years, then I am all for it.

Mr. NATCHER. Thank you, sir.

The CHAIRMAN. In other words, you mean an intensive accelerated program. Is that the way you put it?

Dr. VON BRAUN. Yes, sir; I think this country should put a great effort into a space program. But even more important than the budget figures for the first year is the question of how we can stabilize this program and keep it going at a sustained, accelerated rate over a number of years, how we can eliminate this lethal and wasteful hot-and-cold blowing that has plagued all our missile projects in the past.

I think this lack of steady determination and unwaivering support over the years has hurt us more than anything in the past.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. Dr. von Braun, at what stage did Russia surpass us in missile and rocketry? You state that apparently they are in the lead today. I am curious to know.

You know there have been many statements made. When in your opinion did Russia surpass our efforts, our development, and our knowledge?

Dr. VON BRAUN. Sir, I do not think you could pin this down to a certain date, but they are quite obviously ahead of us now. We have ample evidence that the Russians have ICBM's successfully flying over a range of many thousand miles, whereas we have not.

It is further obvious that the Russians have used such ICBM rockets to launch their two sputniks into orbit. Both of these sputniks, particularly Sputnik No. 2, are many times heavier than our own satellites. Out little Explorers and Vanguards are competing with the sputniks in spirit only. But in terms of rocket hardware they are no match.

Mr. SISK. Doctor, you were leader of a team doing basic research on what we call the Redstone and the later Jupiter. In the development, when did you feel that you had accomplished sufficient basic research to give you information that the weapon could have been used to put a satellite in space?

Dr. VON BRAUN. We fired a three stage vehicle, using the Redstone missile as first stage, for the first time on the 20th of September 1956. It flew over a range of 3,300 miles, with a payload of 84 pounds.

Had we replaced the 84 pound payload of this missile by a fourth stage, as we later on did with the Explorers, this same missile would

have been able to orbit. Thus the earliest possible date would have been September 1956.

Since this was the very first firing of the multistage version of the Redstone, we had time to improve it since September 1956. So it is only fair to add that the chances of success of a satellite firing with this missile have continuously increased.

But nevertheless, the firing of September 1956 clearly demonstrated to us and others then and there that we had a satellite capability with this missile.

Mr. SISK. When did your work start, Doctor, your basic research on the Redstone?

Approximately what year did that work start?

Dr. VON BRAUN. Work on the Redstone started in the spring of 1951. That was when the green light was given for an active development program. Our preliminary design studies began in 1950.

Mr. SISK. Actually it took you a period of some 6 years, then, before you were able to have projected a satellite, irrespective of the size, into space; is that correct?

Dr. VON BRAUN. The Redstone missile is a field weapons system and has not been operationally ready until very recently. In fact, the first operational Redstone unit will be deployed in May 1958.

Thus the total time needed for the development of the Redstone missile system from the word "go" to deployment as a military weapons system in the field, was approximately 7 years.

A satellite capability with the Redstone missile, as I stated before, existed as early as fall of 1956 This was about 5½ years after the initiation of the Redstone program.

Mr. SISK. The thing that I was interested in, Doctor, and I have no desire to put anyone on the spot or embarrass anyone over previous statements, but it was my understanding that somewhere in 1955 it was your opinion that we were still ahead of Russia in basic research.

Frankly, that was the reason I was attempting to bring out some of these things here

Dr. VON BRAUN. Yes, sir; I am very well aware of that. I have even made statements in public to that effect.

My explanation and excuse for these statements is that at that time I did not have complete access to what we really knew about the Russian progress.

Please bear in mind that I received my American citizenship only in 1955. It was only thereafter that I gained access to our intelligence.

Mr. SISK. Doctor, I appreciate that statement. I can understand your position.

As I said, there was no intention on my part to embarrass you with this question.

Are you prepared at this time to say whether or not that intelligence indicated at what time Russia may have surpassed us, or was it just intelligence of 1955 that indicated that?

Dr. VON BRAUN. Sir, the only information I had access to prior to obtaining my American citizenship and prior to my clearance for certain classified intelligence information was based on the reports by German rocket scientists who had returned from Soviet Russia. These men were debriefed by western intelligence agents upon their return to Western Berlin or Western Germany.

The definite impression I got from these debriefings was that the Russians had made very poor use of the German scientists they had

taken into Soviet Russia and that, by and large, the Russian missile program was pretty confused and poorly administered.

It became clear to me only much later that there existed an entirely independent Soviet Russian ballistic missile development program of which the German scientists taken into Soviet Russia were not even aware.

This also answers a question frequently raised these days, namely, what was the probable contribution of German scientists working in Russia toward the sputnik program. I think the answer is "very little."

The CHAIRMAN. Mr. Arends.

Mr. ARENDS. I will pass for the moment.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. I will yield to Mr. McDonough.

Mr. McDONOUGH Dr. von Braun, do you know, or do you have any intimate knowledge of the men that built the Russian sputnik, do you know whether they are men who came from Peenemunde?

Dr. VON BRAUN. No, sir; I am convinced they did not.

As I just said, the German scientists taken into Russia were obviously not even aware of the large and extensive ballistic missile program that was going on inside Soviet Russia. From what we could gather from those debriefing reports, the German scientists were merely squeezed out; they were asked questions like, "How did you do this, and how did you do that?"

They were frequently requested to explain German reports from the Peenemunde archives that had been taken to Soviet Russia. They had to piece old equipment together, and they made lots of design and feasibility studies on paper. But they did not to any appreciable extent actively participate in the hardware phases of the rocket and missile development program in Soviet Russia.

Mr McDONOUGH. Are there any of the original Peenemunde group still inside Soviet Russia working on missiles or satellites?

Dr. VON BRAUN. To my knowledge, not any more.

Mr. McDONOUGH. You attribute the Russian sputnik to Russian scientists, mathematicians, engineers, and physicists?

Dr. VON BRAUN. Yes, sir; absolutely. I believe the Russians made extensive use of the German progress in rocket technology during the last war and whatever they learned from German scientific reports taken into Russia as war booty. But on this foundation they built their own program with their own people.

The sputniks are definitely the result of a Russian program with little if any German assistance.

Mr. McDONOUGH Can you account for, or do you have any reason to believe that there has been a hesitation in their program because they have not sent another satellite into orbit since the second sputnik, and we have sent up three? Is there any reason to believe they are waiting for something, or they have failed in their program?

Dr. VON BRAUN Sir, my personal theory is this·

Since the Russians obviously use ICBM hardware in support of their satellite program, it follows that whatever ICBM rocket hardware is available must be split between two programs, namely, their ICBM program and their satellite program.

So it would appear only logical to assume that after their space people had two successful satellite flights it is now their ICBM people's turn again to get some of the rockets.

Now, this is strictly my personel interpretation, and I must ask you to take it for what you think it is worth.

Mr. McDONOUGH. Is the thrust engine principle that is used to put a satellite into orbit the same in Russia and the United States? Are the basic principles the same?

Dr. VON BRAUN. With the exception of the Redstone that was used in support of the Explorer satellite we have not used any military rocket hardware in our United States satellite program yet.

The Vanguard, as you know, was specifically designed to support the satellite program of the International Geophysical Year. It has no military usefulness. Only in future United States satellite programs will we also utilize IRBM and ICBM rockets.

Mr. McDONOUGH. Do you know whether the Russian physicists and engineers have amplified and expanded the original Goddard theory in rocketry?

I read something about your statement concerning Goddard as one of the pioneers in rocketry and that Peenemunde was pretty much an expansion and application of his original theory.

Is that true in Russia? Did they use Goddard's basic theory in the development of their program?

Dr. VON BRAUN. Sir, I have always considered Goddard one of the three great early pioneers in rocketry, with Germany's Oberth and Russia's Ziolkowsky being the two others. These three men laid the scientific groundwork for modern rocketry. But whereas Oberth and Ziolkowsky were chiefly theorists, Goddard was also a brilliant experimenter. I think Goddard's main dilemma was that he could not find anybody to give him enough money for his more advanced rocket experimentation.

Others were a little more fortunate in this respect, the Peenemunde team in prewar and wartime Germany and the Russian rocket and satellite group today.

Mr. McDONOUGH. In other words, the basic principle of a missile or a rocket is a physical law, that both had to work on.

Dr. VON BRAUN. Yes, sir.

Mr. McDONOUGH. Neither one had the advantage of the other—except that if we can develop an engine with a large enough thrust to overcome Russia, then we are on top of her; and they do have a heavier thrust than we do at the present time?

Dr. VON BRAUN. Yes, sir. This business of large thrust rocket engines is not a question of science at all. It is simply a question of putting enough resources behind such a program to have the engines built and tested.

Mr. McDONOUGH. What is our actual thrust at the present time, do you know?

Dr. VON BRAUN. I don't know if I can answer that question in open meeting.

Mr. McDONOUGH. Also, our maximum thrust is classified information?

Dr. VON BRAUN. I should think it is, but I'll be glad to check.

Mr. FELDMAN. I believe, Doctor, that the newspapers carried the story to the effect that the Russian engines had a thrust of between 250,000 and 395,000 pounds as compared with the Vanguard which had a thrust of 40,000 pounds, and the Jupiter which had a thrust of 83,000 pounds. At least I saw that in the newspaper.

Dr. von Braun. I cannot vouch for the Russian figures you have, I can neither confirm nor deny them. But this much is certain:

Whatever rocket carried Sputnik II in orbit must have had many, many times the thrust of either the Redstone or the Vanguard. That rocket must have had several hundred thousand pounds of thrust.

Mr. McDonough. I have one other question. Mr. Chairman.

Dr. von Braun, is there any advantage in the first takeoff of a rocket, or a missle, to starting it below the surface of the earth and taking the full advantage of the thrust in an enclosure rather than on the surface?

Dr. von Braun. No, sir. There would be some advantage, theoretical advantage at least, in catapulting rockets from underground shafts in order to build up a certain initial speed with ground power.

But usually the penalty you pay for the structural reinforcements needed to handle the catapult loads nullifies the advantage gained.

Mr. McDonough. There is greater advantage in starting from the surface?

Dr. von Braun. Yes, sir.

The Chairman. Did you want to ask some questions now, Mr. Arends?

Mr. Arends. I am going to limit myself to 1 or 2 questions and observations, Mr. von Braun. You may have already answered the question before I got here. Unfortunately I was a little late.

In the second to the last paragraph in your paper, you say:

> Vigorous action is required to overcome as quickly as possible the obvious lead which the Russians now enjoy.

Can you develop that a little bit more? If you developed that with the other gentlemen, it will be in the record and I will look it up.

Dr. von Braun. Yes, I did.

The Chairman. I would like to have it developed more. Why do you not go a little further?

Mr. Arends. I would like to have all the information you can possibly give in open session. I have heard it argued one way or another that in certain fields in the intercontinental ballistic missile we may be behind; in the intermediate range we may be at a certain point. In other missiles we may be ahead of the Russians. Can you explore that a little?

The Chairman. Consistent with national security. We believe that the American public should be informed as fully as possible, the bad as well as the good, because if the American people are given information they can take it.

Mr. McDonough. There have been so many conflicting stories about this I think, to a degree at least, it should be clarified.

Dr. von Braun. Sir, I am not aware of any evidence that either in the ICBM or in the IRBM field we are in any way ahead of them. On the contrary, every available evidence that I have seen indicates that the Russians are ahead of us in both.

Where we stand in short-range missiles, I do not know.

Mr. McDonough. Let me ask you another question:

Are you satisfied with the programs and the speed of progress today as you visualize our overall program of the objective things we must do? Are you satisfied with the speed and the progress of the program as you visualize it at this moment?

Dr. VON BRAUN. Sir, I think we won't ever be satisfied in this area. I think we can always work a little faster by removing a few more obstacles.

Many new projects have been initiated since the advent of the sputniks. I think, by and large, this new program is well planned, well conceived, and in competent hands. There are, of course, many obstacles to overcome, such as making enough money available early enough for these new projects. These things just seem to take their time.

Mr. McDONOUGH. Would you say in a general way that we are putting forth full effort?

Dr. VON BRAUN. I think there is a great effort going on now. Whether that effort is adequate to build up sufficient momentum to match the Russian program in working speed and finally to overtake it, I am not prepared to say.

In fact, I have my doubts whether what we are doing is enough.

Mr. McDONOUGH. I will ask one more question. Are you in any way handicapped in your efforts by lack of sufficient funds?

Dr. VON BRAUN. Sir, may I speak for the Army ballistic missile program only?

Mr. McDONOUGH. Yes.

Dr. VON BRAUN. With your permission I would like to go into a little more detail on this. We work on three different weapons systems projects at the Army Ballistic Missile Agency at the moment. One is in its final stages. It is the completion of the fielding process of the Redstone missile system; in other words, making more and more Redstone firing units available to the troops.

As far as research and development is concerned, the Redstone program is almost complete. There are only a few limited cleanup tasks such as a winterization program going on in this area.

I do not see how this work could be expedited by more funds. It is coming along very well.

As far as our second project, the Jupiter program, is concerned, I think you know that we are developing the Jupiter system in a kind of competition with the Thor system for the Strategic Air Command of the Air Force. This program, in my opinion, is also financially as well supported as can be. For a while this program did suffer from lack of funds to get Jupiter production started in our prime contractor's plant, but these difficulties have been overcome quite recently. Right now I do not think that much more money could be wisely spent on this program.

Our third program is quite new. It is the Pershing missile system, a medium range ballistic missile system, using solid propellents. We develop Pershing for the Army.

This program in my opinion is also adequately supported moneywise. The development, production, and deployment schedules envisaged for it are sound and realistic. Pershing is not a crash program which is speeded up to the point where we would be continuously operating beyond the point of diminishing returns.

I think the Pershing program is soundly conceived and supported in every respect.

In addition to these three weapons systems programs, we have a number of specific assignments from the newly formed Advanced Research Project Agency under the Office of the Secretary of Defense.

These assignments involve special missile flights in the area of space exploration, such as satellite flights and other special space missions.

In this area I believe that as far as calendar year 1958 is concerned, we have bitten off as much as we can chew. However, it is urgently necessary that we get more money now for the procurement of basic rocket hardware which we need for our part in the national space program that we are supposed to play in calendar year 1959. We need this money now because of the long lead times involved in the procurement of large rocket engines, guidance, components and the like.

Mr. McDONOUGH. That is a very good answer, Dr. von Braun. If I understand the opinion of the Congress, it is this; that we want to give you all the money you need to do a good job, but certainly we do not want just to throw money in your lap, which, as you say, might not be well spent for the efforts you are engaged in.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. Dr. von Braun, we are glad to have you here and glad to know of your interest in the program and compliment you on being an American citizen.

You, in 1955, were in a moving picture that had quite an influence on me. It was a satellite film on developments to come. I might say, like Jules Verne's Twenty Thousand Leagues Under the Sea, it has been remarkable how everything you predicted in that 1955 film, I would like to say publicly, has come true. If we had been more alert on your warning, we could certainly, in the United States and the free world, have been further ahead.

Because of your interest I, as a commander in the Navy Reserve, have been at Cape Canaveral on duty and on various missile ships. So I am interested in your program.

Would it help you as a matter of organization to have Congress set up a committee primarily responsible in this particular field so there would be close liaison and policy guidance to you as you carry out your work? Should we in Congress have a special space committee set up so that we can work with you on a civilian basis, having regard to the military aspects and the scientific aspects both?

Would that be of help?

Dr. VON BRAUN. Sir, I believe it would be of great help indeed, and mainly for the following reason:

I think there is always the danger in a thing like the present space rush, that after the first excitement is over people might go to sleep again. Thus we may get a lot of money for 1 or 2 years, but then the space program may become ever less important as time goes on, particularly if the Russians do not come up with new surprises.

I think the most important single requirement of a sound national space program is that it be a sustained effort, so that we can really plan ahead, that we will know how much money will be available not only in 1958 but also in 1959, 1960, 1961, and 1962, and we really know that Congress and the American people mean business in taking up the Russian space challenge.

Mr. FULTON. So you would then recommend a permanent setup in Congress of a committee having primary jurisdiction of the space field, both scientific and military with the idea of setting policy for long-term national space program development?

Dr. VON BRAUN. Yes, sir.

Mr. FULTON. Would it be helpful to you in the scientific field and not in the legislative field, to have a joint committee of the Senate and the House in order that you would not have to duplicate your testimony before two bodies? Would it make it easier for the scientists involved in the program to come up before one joint committee rather than a committee of the House and a committee of the Senate?

Dr. VON BRAUN. Sir, I am not very experienced in these matters, but I think the Joint House-Senate Committee on Atomic Energy has set a very fine precedent here and has proved that it can work and work very efficiently.

Mr. FULTON. Then you would really recommend a body in the administrative branch that is a civilian body for the space agency, having cognizance a good bit like the Atomic Energy Commission would; is that about your view?

Dr. VON BRAUN. Yes, sir.

Mr. FULTON. You have recommended a change in program, that the United States should not continue research and development that serves only immediate military use. I believe that is good. I think you feel we should broaden the scope of the space program and look at it not only in the missiles and the weapons systems area, but likewise in the vehicle and space ship fields; is that right?

Dr. VON BRAUN. Yes, sir.

Mr. FULTON. May I ask on that end of it—we have about 11 programs on the weapons systems going on at the present time—would it help you if there were more liaison among the teams working on these various programs, better liaison and more interchange of scientific knowledge?

Dr. VON BRAUN. Yes, sir; I think improvement in this area is definitely possible, although there is more liaison than most people realize.

For example, we are continuously exchanging information and experience on flight results between the competitive Jupiter and Thor programs and at Cape Canaveral there are regular visits between firing crews engaged in different programs.

Mr. FULTON. Is the Government supplying you with enough translated material and research material that appears in various magazines over the world so that you are not hampered in your agency.

Dr. VON BRAUN. We believe there is a particular lack of good information coming over from Russia. Time and again we found out, rather belatedly, that things which hit people in this country by surprise had been published in Russian trade journals or professional magazines as early as a year before we heard about it.

Mr. FULTON. Would you recommend in the Library of Congress, or some agency of the Government, that there be set up an agency which takes primary responsibility on seeing that the scientific developments of the world are brought in and made available to people working on these projects such as you?

Dr. VON BRAUN. Yes, sir.

Mr. FULTON. Let me ask you specifically on a couple of programs. In order to have military capability in outer space, it would be, of course, best to have a space platform of some size that could be manned. How long would it take you people to put up a space platform if you started into a program with adequate means supplied by Congress?

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The CHAIRMAN. And, of course, the instructions to go ahead.

Mr. FULTON. And the instructions to go ahead; that is right.

Dr. VON BRAUN. Sir, I think instead of using the term "manned space platform", one should use the expression "manned orbiting vehicles of any kind or shape."

Mr. FULTON. I was trying to get away from the weapon itself, or the missile. Let us call it a vehicle.

Dr. VON BRAUN. I suggest this change in terminology because there has been some argument as to whether a space platform without any capability of maneuvering from one fixed orbit to another would not be a bit vulnerable, just like a modern airbase. Many military planners believe that a smaller orbital vehicle with reconnaissance or even bombing capability, that would go around the earth only a few times and then land, would be more effective.

Thus, to answer your question about our earliest military capability in outer space we should disregard the schedule for a large space platform which is essentially nothing but a housing facility in outer space which provides people with working and sleeping quarters. Your question would then simply be: "How about warfare from an orbit?"

Mr. FULTON. How soon could you put up a manned vehicle that orbits?

Dr. VON BRAUN. Is your question directed at the Army Ballistics Agency?

Mr. FULTON. I would say to you personally. If you were given the go-ahead and as Mr. McCormack very accurately says, the instructions to go, how soon could you put up a manned vehicle that orbits around the earth?

Dr. VON BRAUN. I think within about 2 to 3 years we could put a man into orbit and get him back alive. It would take about 5 years to have an orbital vehicle with a limited military capability.

Mr. FULTON. That actually would take less thrust than it takes to get a rocket either to hit or orbit the moon, would it not?

Dr. VON BRAUN. To go from an orbit around the earth to the moon takes less thrust. If you want to go from the surface of the earth direct to the moon and back, it would take more.

Mr. FULTON. How soon can you put a rocket up that will try for the moon, either to hit it or to orbit?

Dr. VON BRAUN. To hit the moon and even more so to orbit around the moon, is not so much a problem of having the rocket power, but of having a sufficiently accurate guidance system.

Mr. FULTON. We really could at this point aim a rocket at the moon, if we did not care whether it missed on mathematical calculations right at this time, could we not?

Dr. VON BRAUN. Yes, sir; within a relatively short period of time it will be possible to shoot the small top stage of a large multistage rocket even past the moon and out into interplanetary space so that it permanently escapes the gravitational pull of the earth.

This is simpler than hitting the moon.

Mr. FULTON. Why do we not try to ask the President to give you that power to take a crack at the moon even though you do not hit it? Would you like that?

You see, the trouble with us in the Vanguard was that we were so careful and we were trying to get it with such precise scientific instru-

mentation in it and likewise to have the solar energy to keep the batteries going 3 weeks that the Russians beat us.

Why not take the crack at the moon on mathematical calculations?

Dr. von Braun. The Advanced Research Project Agency has recently approved just such a program and we are working on it at the Army Ballistic Missile Agency right now.

Mr. Fulton. Now, you are not holding it back to make it so accurate that you will not make a mistake while the Russians go ahead on something very daring and get ahead of us? That is what I am afraid of.

Dr. von Braun. I suggest you direct any more questions you may have in this area to Dr. York, who sits right next to me.

Mr. Fulton. You have the thrust right now that you could, with the proper calculations, make a pretty good miss at the moon; do you not?

Dr. von Braun. Yes, sir.

Mr. Fulton. Then why do you not do it? Why are you waiting all this time to get instrumentation and all the things you are talking about orbiting and coming in a U-shape around the moon and back?

Dr. von Braun. We are not waiting for that. We are moving precisely in the direction you indicated.

Mr. Fulton. How soon do you think we will be taking a crack at the moon?

Dr. von Braun. To hit the moon, or pass it?

Mr. Fulton. We have the capability right now. We could go down too.

Dr. von Braun. We are working on this project as fast as we can, sir.

Mr. Fulton. Why stop at orbiting now? Why not just try it?

Dr. von Braun. We will try to shoot past the moon as soon as we have the capability. It is essentially a question of engineering, building the missiles, testing them and checking them out on the ground. We shall fire them as soon as they are ready.

Mr. Fulton. At what speed did you orbit the various vehicles that you have now?

Dr. von Braun. Approximately 18,000 miles an hour.

Mr. Fulton. So you only have to get the instrument 7,000 miles an hour faster until it does an exit performance?

Dr. von Braun. Yes, sir.

Mr. Fulton. Then why do you not get some astronomers and they will calculate where the moon is going to be at a certain point?

Dr. von Braun. Our problem is that in order to get those additional 7,000 miles an hour we need a different missile than our Jupiter C. We cannot do it with the same basic missile that put the Explorer up there. That extra speed requires the development of some new missile hardware and we are working on this right now.

Mr. Fulton. Once you get a thing like a projectile into outer space, why is that not good enough? Why do you do all this development? I am talking more of what the public thinks.

You are being so careful and making so sure it is accurate that maybe the Russians will take a bang at the moon and hit it first.

Dr. von Braun. They may very well do just that. There is nothing we can do about it. You can rest assured, sir, that we are doing it with the simplest available means and as fast as we can.

Mr. FULTON. You have the thrust right now to get out of the earth's atmosphere; you have the speed to do it; you have the instruments down there at Cape Canaveral to get out of the atmosphere, so why do you not very quickly just take a target shot?

Dr. VON BRAUN. We got the green light to do this just 2 weeks ago. Projects of this magnitude involve lead times. We have to procure things. We have to design things. We have to test them out. Otherwise it does not work.

Mr. FULTON. How long after you were told to go ahead—after the Vanguard had its sputternik—how long did it take you to put an instrumented vehicle in orbit around the earth's surface?

Dr. VON BRAUN. Eighty-four days.

Mr. FULTON. Can you do the same on the moon?

Dr. VON BRAUN. No.

Mr. FULTON. How many days?

Dr. VON BRAUN. Sir, I would rather answer that question after it has been done.

Mr. FULTON. I didn't say hit the moon, but you can already get out of the earth's atmosphere now. How soon, in days, could you take an aim at the moon even if you miss?

Dr. VON BRAUN Sir, there is a fundamental difference between this task and our Explorer I satellite firing. In the case of Explorer I we took a reentry test vehicle that was already in existence and we quickly revamped it for a satellite firing. That is why it could be done in 84 days

In the case of a shot at the moon, hit or miss, we have to start at the bottom. Maybe even here we do not have to start quite from scratch, but we still have to do a lot more basic design, manufacturing, testing and computing work and this requires many months.

Mr. FULTON. Actually, the apogee we have with our present vehicle that is orbiting is 1,500 to 2,000 miles, which is much higher than the Russians ever got; is it not?

Dr. VON BRAUN Yes, sir.

Mr. FULTON. Likewise we are using solar energy and they never used solar energy in any of their vehicles; did they?

Dr. VON BRAUN. Not to our knowledge

Mr FULTON Thank you very much.

The CHAIRMAN. Mr. Keating

Mr. KEATING. Dr. von Braun, one of the problems which this committee will want to consider will be the legislation which was introduced by the chairman and others relating to the establishment of a new space agency. You have already made one comment on that.

Do you have any other comments or views for our committee as regards legislation?

Dr. VON BRAUN. Sir, I replied to a question about the committee organization within the Congress, there is also the question of that new Astronautics and Space Act and NACA's future role in our national space program.

Mr. KEATING. The question is whether and in what respects it could be meshed into the work you are doing and whether the legislation that has been proposed is adequate to meet the problems.

It may be that you have not studied it enough to give us help, but it would certainly be well received, if you could.

The CHAIRMAN. Any questions asked, Doctor, of any of the witnesses which they would like to consider and answer later, they may do so. You will have an opportunity to edit your replies. That will be afforded all witnesses.

If you cannot answer it and it is not classified, you can state that you will be glad to answer that later when you are editing your testimony?

Dr. VON BRAUN. Yes, sir. I do not believe that the question asked by Congressman Keating involves any classified matter.

The CHAIRMAN. I was not referring to that particular question. I am just making that statement so that you gentlemen will understand.

Dr. VON BRAUN. Yes, sir. I am familiar with the administration bill called the Astronautics and Space Act of 1959. This act in essence proposes to build the astronautics and space agency around what is presently the National Advisory Committee for Aeronautics.

My personal reaction is that I find myself in basic agreement with this bill. However, I think the success of the space agency will greatly depend on the authority vested in it, and I do not believe under the present NACA charter NACA or its legal successor would be quite prepared to handle a program of this magnitude. I strongly believe that it will be necessary to put a few more teeth into the NACA charter to make it capable of handling this space assignment.

On the other hand, if these teeth are really put into the NACA charter, and if NACA would really be handed the money to run an adequate space program, then I could not think of a better solution, or of a more competent nucleus for a space agency.

Mr. KEATING. Could you be any more specific at this point? I realize that it is perhaps too early for you to say, but could you be any more specific about what you mean by "teeth in it?" Do you mean by that there should be provisions in the legislation which this committee should consider?

Dr. VON BRAUN. Sir, to put it in very broad terms NACA, as the name implies, has so far been an advisory committee for aeronautics which means the emphasis has been on "advice."

In addition to furnishing advice NACA has provided research support for projects carried out by the aircraft industry. This work has been performed in NACA's wind tunnels, structural laboratories, propulsion-test facilities, and so forth.

It is my opinion that if the newly formed National Astronautics and Space Agency is really to run a national space program, it must be given enough authority and an adequate managerial staff to centrally administer such a large and costly program. My feeling is that in order to handle this assignment, the National Astronautics and Space Agency would need a charter like that of the Atomic Energy Commission, in lieu of the charter under which NACA presently operates.

Anything short of that would probably not work out so well. After all, there is a tremendous amount of money involved in these projects, and an adequate administration of this program requires a large program management staff as well as a group of executives who can make decisions, which, incidentally, sometimes may be quite painful.

Mr. KEATING. You do not envision any difficulties or interference with the military effort in this field by the provisions of this bill as it now is drawn? You think it is perfectly possible to give proper

recognition and cognizance to what our military are doing in this field under the provisions of this bill?

Dr. VON BRAUN. Sir, I think NACA's record proves beyond a shadow of a doubt that for many years it worked very smoothly with the military services.

Likewise, the Atomic Energy Commission, also a civilian agency, has established a splendid record in working with the military services and in responding to their requirements.

I think all this is merely a question of sound administration, of proper spirit and of a good charter. I believe there is no need to fear a basic conflict between a civilian agency and the military services.

Mr. KEATING. Thank you very much.

The CHAIRMAN. Doctor, what do you gentlemen who are specialists generally consider the field of outer space or space exploration, how many miles from the earth? Generally speaking. Would it be 100 miles, 200 miles, or what?

Dr. VON BRAUN The atmosphere just gets thinner and thinner the higher you go. There is no clear-cut upper end.

People have agreed to refer to outer space when an altitude has been reached where our most sensitive instruments can no longer indicate the presence of any air.

But as our instruments have become more sensitive the altitude of the atmosphere has continuously gone up.

The CHAIRMAN. Mr. Ford.

Mr. FORD. Dr. von Braun, in your prepared statement you indicate that it is wise to have some overlapping in various missiles and possibly satellite programs. At the same time you caution against avoiding costly duplication.

Would you care to comment whether or not the Jupiter and Thor programs as they developed fell into the proper category? Can you define a good program?

Dr. VON BRAUN. Sir, first and foremost, much of this is a question of priority, of national importance. When there is a very urgent need to get a weapons system in operation as soon as possible it is always a good idea to have two sources and a certain amount of competition.

I think both the Jupiter program and the Thor program have been effectively speeded up simply on account of the existence of the other. It is just plain good business to have competition.

But in addition one should never forget that we all are continuously taking grave risks in these new missile programs. Any one of our missile makers may all of a sudden run into some kind of unexpected technical trouble that may delay the field deployment of his weapons system by as much as a year.

By having two IRBM programs and two ICBM programs we are just playing it safe.

Now it has been said that the Jupiter and the Thor are very similar because their basic military characteristics, expressed in terms of maximum range and payload carrying ability are the same. However, when it comes to details, there are many and most important differences.

The Jupiter has an entirely different nose cone, both in design and material.

The Jupiter has an entirely different guidance system from the Thor. Even the airframes of the two missiles are built along entirely different lines.

The supporting ground equipment is built on a different philosophy. Thor puts all the emphasis on readiness for an immediate retaliatory strike, no matter how heavy and cumbersome a ground installation you need to get that result. Whereas Jupiter took a leaf out of the Army's mobility book by saying, "We would like to be able to move around and change our launching sites frequently even if that requirement makes our immediate retaliatory capability a little more difficult to obtain than if we were to adopt the Thor concept." In other words, Jupiter offers mobility; we don't need any fixed bases.

Now, I think notwithstanding all the papers written on this subject, nobody can really say today which is the better approach. Nor can anyone decide today whether Jupiter or Thor has the better nose cone or the better guidance system. The only way to find out is by building both missile systems concurrently and by evaluating the performance of both.

Mr. FORD. From the point of view of the country's national security, it was wise to proceed with the research and development of both systems.

Dr. VON BRAUN. I am convinced of that.

Mr. FORD. Would you say that the same applies as far as the ICBM programs, the Atlas and the Titan?

Dr. VON BRAUN. Yes, sir. You have exactly the same situation there.

In this case both missile systems were developed right from the outset by the Air Force, and the Air Force itself has always considered it advisable and smart to develop two competitive ICBM's.

I think what is right and logical for the ICBM is just as right and logical for the IRBM.

Unfortunately, the fact that the Army originally had initiated the development of the Jupiter, whereas the Thor development was initiated by the Air Force, has thrown an element of interservice rivalry into the comparison of the two. Ever since the roles and missions assignment for the IRBM was given to the Air Force, statements have been made that the Air Force really does not need the Jupiter, that it would be happier with only one IRBM, the Thor, of course. But look at the ICBM's. They were both initiated by the Air Force and you still have two ICBM's.

Mr. FORD. In other words, if the Jupiter and the Thor had been developed by one service rather than two, it still would have been a wise decision to proceed with the research and development and the actual execution of the procurement?

Dr. VON BRAUN. I am convinced of that.

Mr. FORD. Would you say the same as far as the Polaris system is concerned?

Dr. VON BRAUN. The Polaris situation is very different. Polaris is supposed to be a submarine missile and it is quite obvious that neither the Thor nor the Jupiter lend themselves well to submarine application.

Conversely, if you tried to replace Jupiter by a missile like Polaris, and you want to move it around the countryside, you'd find its mobility rather limited, because its solid rockets cannot be loaded or fueled in the launching site like a liquid fuel rocket. So you always have to handle the fully loaded missile, and to truck such a heavy item around the countryside would be quite difficult.

The Navy, of course, need not bother about this drawback at all because they would load the Polaris missiles into the submarine in a

harbor where large harbor cranes are available, or they would reload the sub out on the ocean from a fleet tender which also would have suitable ship cranes or loading booms available for this operation.

Mr. FORD. Since early 1958 there has been set up ARPA. It has been given the right to control certain obligational authority in both the Air Force and the Army and, of course, in the budget proposal for fiscal 1959, originally as I recall it was $340 million.

In the second supplemental I think it was around $180 million, making something over $530 million or $540 million for ARPA's operation as opposed to fiscal 1959.

In your view, is there adequate funding in ARPA in fiscal 1959 for the program that you feel has priority?

Dr. VON BRAUN. Sir, to my knowledge the $500 million you just quoted for ARPA are not exclusively for an outer-space program. Much of this is earmarked for direct support of the existing ballistic missile programs and other related military programs.

I think for outer space there is no more than $250 million, something like that, maybe $300 million.

Mr. FORD. Included in the five hundred and some million dollars for ARPA, in fiscal 1959 that is, there are funds for the Nike-Zeus; are there not?

Dr. VON BRAUN As far as I know, yes, sir.

Mr. FORD. Could you tell us how your office at Huntsville works in relationship to ARPA?

Dr. VON BRAUN. ARPA is giving us task assignments for certain experimental rocket flights in the outer space area such as satellite launchings or the lunar escape flights which were previously discussed in this hearing We have a certain number of such projects assigned to the Army Ballistic Missile Agency in Huntsville from ARPA Our 1958 program is well underway.

What we badly need and quickly, is full funding for our 1959 program for ARPA because there are long lead times involved to buy rocket engines and airframes and guidance and control components to draw from, because our entire supply of these components is earmarked for our military obligations, in other words, for the Redstone and Jupiter weapons systems.

Let me be more specific here. We have assumed certain obligations toward the Air Force to supply the Strategic Air Command with a specified number of Jupiters beginning in early 1959 and following up throughout calendar year 1959. Every single Jupiter rocket engine, every Jupiter guidance system presently on order is committed to this program, and has been financed out of ballistic missiles funds.

If we are to launch satellite or moon or escape vehicles based on the Jupiter missile for ARPA during calendar year 1959, we have to buy Jupiter engines, Jupiter airframes, and Jupiter guidance components right now, no matter what the specific space missions of these rockets will be, because they all will need Jupiter engines and they all will need Jupiter guidance systems.

In this area we need more money badly. ARPA itself does not have that money at the moment.

Mr. FORD. In the fiscal 1958 availability?

Dr. VON BRAUN. I am talking about money for fiscal 1958, that must be spent now in order to buy a calendar year 1959 space capability.

Mr. FORD. Would it be your offhand comment that the establishment of ARPA was beneficial as far as the space program, related program, is concerned?

Dr. VON BRAUN. Yes, sir; very definitely.

Mr. FORD. You made the comment earlier that the Vanguard was a nonmilitary powerplant. Does it have a military capability, if needed, or one that is adapted to a military capability?

Dr. VON BRAUN. Military capability of at least certain elements of the Vanguard missile, such as the first stage, is definitely conceivable.

I am not aware of any military program envisaging the use of Vanguard hardware at this moment.

Mr. FORD. In the space program do you ever envision the use of a solid propellent in your first stage?

Dr. VON BRAUN. In the first stage?

Mr. FORD. Or in any stage?

Dr. VON BRAUN. We are using solid propellents in the upper stages in the Jupiter C when firing our Explorers.

Mr. FORD. I was thinking of the main thrust. Is solid propellent feasibile or desirable?

Dr. VON BRAUN. The general tendency for solid propellent rockets is to become available in ever larger units, but as larger and larger solid rockets are being built the thrust and burning time of liquid rockets is also going up.

As of today, when it comes to total rocket impulse (by that we mean the product of thrust times operating time) the liquid rocket still beats the solid rocket by a very large margin.

Mr. FORD. I believe that is all, Mr. Chairman.

The CHAIRMAN. Mr. Brooks, do you have some questions?

Mr. BROOKS. Doctor, I want to ask you a few questions along a little different line than what has been covered. You have been down at Redstone how long?

Dr. VON BRAUN. Since 1950.

Mr. BROOKS. You have been working all that time on missiles?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Now, are they principally military missiles that you are working on, or are they purely scientific programs?

Dr. VON BRAUN. Sir, our main missions have always been military missiles, the Redstone and the Jupiter and now the Pershing.

But in order to effectively pursue the development of military missile projects, you sometimes have to assign missiles for supporting research tasks.

Mr. BROOKS. That is one of the points I am getting at. In order to develop your military missiles you must apply pure science and the missiles you develop may be interrelated with peaceful uses; is that right?

Dr. VON BRAUN. Yes, sir; we have used the Redstone missile to make nose cone reentry tests for the Jupiter program and then used this very same missile also as our Explorer satellite carrier.

Mr. BROOKS. Would you say that the Jupiter was a military development, too?

Dr. VON BRAUN. The Jupiter is a military development. Jupiter C is the multistage missile based on the Redstone which was developed

for scientific support of the Jupiter development program, particularly to test nose cones.

Mr. BROOKS. So it essentially is military, too?

Dr. VON BRAUN. It was financed with military funds because it was necessary——

Mr. BROOKS. You take your orders down there from the military; do you not?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Are you given frequent opportunities to explore peaceful development of the missile program and the satellite program?

Dr. VON BRAUN. To the extent that ARPA sends us orders, yes, sir; these assignments utilize a limited portion of our shop and laboratory capacity.

Mr. BROOKS. You follow the orders that come from the Pentagon?

Dr. VON BRAUN. Yes, sir. Right now about 20 percent of our capacity at the Army Ballistics Missile Agency is used for the Advanced Research Project Agency (ARPA) for scientific programs whereas about 80 percent is assigned to military weapons systems.

Mr. BROOKS. Twenty percent is for science?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Whether it will be adaptable to military or nonmilitary purposes?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Now, in pushing this program on September 20 you received a stop order—September 20, 1956, you received a stop order on the Jupiter-C. That is true; is it not?

Dr. VON BRAUN. After we had fired the first Jupiter C over a range of 3,300 miles we had hoped that this would persuade the Pentagon to give us permission to try a satellite launching, but this hope never materialized.

Mr. BROOKS. If you can say without disclosing any military secrets, how high did that missile go?

Dr. VON BRAUN. 680 miles.

Mr. BROOKS. And 3,300 miles distance.

Then the next day you got a stop order to stop development; is that not true?

Dr. VON BRAUN. No, sir; we were permitted to continue to use this missile for reentry testing of our Jupiter nose cone models, but we were not permitted to make a satellite launching.

Mr. BROOKS. So you got a stop order for any development of more distance or more elevation in that missile?

Dr. VON BRAUN. Specifically we were not permitted to fire into orbit.

Mr. BROOKS. In the meantime the Russians sent up a satellite.

Now, you finally did send the Jupiter-C off into orbit after 83 days, I think you stated.

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Could you have done that in 1956?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. In that event we would have been 1 year ahead of the Russians in development had you been given a free opportunity, the green light as we say, to go ahead with the program?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. We would have been a year ahead of the Russians?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Now, you say the Russians are ahead of us in certain developments of this missile program. It would seem to me that we were ahead of the Russians in this particular program.

Dr. VON BRAUN. Sir, a satellite launching in 1956 probably would have required a little more luck than we needed now—a year and a half later—which offered us quite a little bit more time to shake down the rocket hardware. Also, our satellite weighs only about 30 pounds, including the empty casing of the last stage.

We should not lose sight of the fact that Sputnik II weighs 1,280 pounds.

Mr. BROOKS. Is there any significance in the difference in weight of the sputnik and the Jupiter-C?

Dr. VON BRAUN. Yes, sir; it means that whereas the light Jupiter-C payload was lifted off the ground with about 80,000 pounds takeoff thrust, the Russian sputnik rocket must have had several hundred thousand pounds thrust to put that much greater payload in orbit.

Mr. BROOKS. Does that show more efficiency on the part of our rockets?

Dr. VON BRAUN. No, sir; it means, by way of comparison, that they have a large cargo aircraft at their disposal compared to which ours would look like a pigmy airplane.

Mr. BROOKS. What we need is development of more cargo-carrying capability for our missiles?

Dr. VON BRAUN. Yes, sir; and our ICBM's will have that cargo carrying capability, too, but the trouble is that they do not yet fly over the full range whereas the Russian ones do.

Mr. BROOKS. You cannot develop that out of the Jupiter C?

Dr. VON BRAUN. No, sir.

Mr. BROOKS. If we were able because of our development to have gotten ahead of the Russians by 1 full year, I want to ask you this: How you find our scientists in this country? Do they seem to compare with those that you have had any acquaintance with in Russia or Germany?

Dr. VON BRAUN. Sir, I think in this country we have all the scientists and engineers it takes to do the job.

Mr. BROOKS. Do we have the scientists over here and the scientific ability in the United States to keep up and get ahead of the Russians in this development?

Dr. VON BRAUN. Yes, sir; absolutely.

Mr. BROOKS. You do not find anything critical or wrong with the training of our scientists in general?

Dr. VON BRAUN. Sir, this is a long story in itself. I do not want to make a sweeping statement.

Mr. BROOKS. You are in a position where you can pass judgment, if you will in a general way, upon the ability of American scientists to do this type of job.

Dr. VON BRAUN. Sir, I am seriously concerned about the momentum of the Russian educational program. I feel very strongly that we should not underestimate it, but should really do something about it. This is a fateful national problem, a more serious threat, in the long run, than even satellites and ballistic missiles.

Mr. BROOKS. You feel strongly we should develop our own people to the limit of our ability to do so?

Dr. von Braun. Yes, sir

Mr. Brooks. You find nothing critical or wrong with our scientific staffs now?

Dr. von Braun. No, sir. I think we have the capability to do it, but we cannot afford to sit back and relax either.

Mr. Brooks. Now, when I was home the other day people began to say, "What is the advantage of putting a platform up in space?" Can you tell us here what is the advantage to this country of putting a platform in space and keeping it there for any extended period of time?

Dr. von Braun. I believe this famous platform in space should not be singled out as one particularly significant achievement. I think we should look upon outer space with somewhat different views.

The same goes for the often repeated question as to what extent this space business is a scientific effort, and to what extent it is a military effort.

I think most of these questions assume a new perspective when we only realize that the exploration of space has become technically possible now due to the general progress made in the art of building large missiles. This has led us into a situation which is in some respects similar to that of shipping shortly after the invention of the compass

All of a sudden it became then possible to leave the shores and cross the oceans and explore distant lands. Claims were staked out and trade routes developed, but very soon thereafter the nations sponsoring such exploration felt that they had to protect their expeditions and foreign footholds and trade lanes and this brought frigates and caravels and finally full-fledged navies into the act.

Very much in the same way I think, in the long run we cannot hope to pursue a purely scientific or economical program of exploration of outer space without a minimum amount of military backing. Let us not forget that the Spanish did not and could not only send cargo ships over to Central and South America to explore and exploit and colonize these lands, they soon found it necessary to build their armada to protect this operation.

Mr. Brooks. So the significance you attach to it is military?

Dr. von Braun. No; not all military. Exploration of new lands, whether in Central America or on the moon, should be a double-barreled approach. The scientific exploration comes first, but the military protection of it must go hand in hand with it.

Mr. Brooks. You find no peaceful approach to it, then?

Dr. von Braun. Sir, I think history is full of examples that prove that one-sided unilateral statements by any one nation on some principle such as the freedom of the seas are rather meaningless unless that nation has a navy to back up that statement in case of trouble.

I think the same can be said about our forthcoming ventures into outer space. I am all for a universally accepted rule that outer space is just as free as the open ocean, but I think unless we as a nation or the United Nations have some means to back this rule up, it would remain a very meaningless, empty statement.

The Chairman. Might I interject there?

Particularly if some other nation got there ahead of us?

Dr. VON BRAUN. If they got up there first, we may have lost a battle, but we still would not have lost the war.

Mr. BROOKS. Of course, you feel that the control of outer space means the control of the universe?

Dr. VON BRAUN. The universe is a rather big place.

Mr. BROOKS. Let us limit this to the world, this earth.

Dr. VON BRAUN. I have not the slightest doubt that the question of whether we or another nation has control of the spaces around the earth will have a very great impact on our military position on the earth itself.

In other words, space superiority, control of the spaces around the earth, will soon be just as important as air superiority is today.

The CHAIRMAN. When you edit that answer will you elaborate on that, Doctor?

Dr. VON BRAUN. I shall be glad to.

Mr. BROOKS. Why do you not let him elaborate on it now, Mr. Chairman?

The CHAIRMAN. Go right ahead.

Mr. BROOKS. Do you want to elaborate now?

Dr. VON BRAUN. Orbiting vehicles have a reconnaissance capability, for example. You can look down on lands which are not accessible by aircraft because of iron and bamboo curtains and the like. So the privacy of military preparations behind such curtains will cease to exist with the advent of the reconnaissance satellite. That works both ways, of course. A Russian reconnaissance satellite can likewise look down on our SAC bases and our naval ports. Any secret military preparations anywhere in the world will become very quickly impossible

Mr. BROOKS. We can look down on their atomic-energy program, too?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. There is one more thing I want to develop and then I am through. I want to ask you this:

You have said a lot about outer space. I have heard the military refer to it as different elevations. Normally in your work in outer space what elevation would you place? Would you say 60,000 feet above the earth, above that would be outer space?

Dr. VON BRAUN. I think 60,000 feet is still a happy hunting ground of the present-day Air Force.

Mr. BROOKS. You would figure above 60,000 feet would be outer space?

Dr. VON BRAUN. I would say outer space begins above 100 miles.

Mr. BROOKS. Below 100 miles is inner space?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Thank you very much, Doctor.

The CHAIRMAN. Mr. Hays, do you mind if I ask a few questions? I have to go over and take the Chair.

Mr. HAYS. Certainly.

The CHAIRMAN. Doctor, coming to the immediate problem that concerns me, you have indicated that the Soviet Union is ahead of us in the field of ballistic missiles; is that correct?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. That means both intermediate and intercontinental?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. Would you care to express an opinion as to how far you think they are ahead of us in the field of intermediate missiles, in point of time?

Dr. VON BRAUN. It looks like they have an operational capability in this area right now, whereas we don't.

The CHAIRMAN. How far would you say in the field of intercontinental ballistic missiles?

Dr. VON BRAUN. They have tested theirs successfully over the full range, where we don't.

The CHAIRMAN. The fact of their last satellite would indicate they have a propulsion power for a considerable distance for intercontinental ballistic missiles, of course, with certain perfections and so forth. I am talking now about propulsion.

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. How far would you say they can shoot their intercontinental ballistic missiles? Five thousand miles? Fifty five hundred miles, or six thousand miles?

I am not saying they have perfected it.

Dr. VON BRAUN. I do not know whether I can answer this in open session. This may be classified information.

The CHAIRMAN. It is very important that we always have a retaliatory power, is it not?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN We would be in a position where they can hit us and we cannot hit them. That is vitally important, is it not?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. The probabilities are if we ever got in that position they would not let us catch up with them. Is that a fair statement to make?

Dr. VON BRAUN. Yes, sir; it would certainly put us in a very difficult situation and subject us to all kinds of blackmail.

The CHAIRMAN. So the field we are looking into in your opinion is a very important field, the inquiries that are being made now in this hearing?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. From a nonmilitary angle why is information concerning the outer space important? What tactical use can be made of such information from a nonmilitary angle?

Dr. VON BRAUN. Sir, I think the whole idea of exploration of space began with the same motives that have always triggered scientific progress. People are just curious and want to pursue certain new promising lines of scientific exploration. What follows in the wake of their discoveries is something for the next generation to worry about. I think it has always been that way

The CHAIRMAN. While our immediate problem might be on the military level because of the law of self-preservation, nevertheless, is it fair to say and is it your opinion that, from a long-range angle, projecting your mind as far as you can as to the uses that can be made of outer space, and we know that many more might come later—you gentlemen certainly are pioneering—would there be a great advantage to the people of the world from a peaceful angle?

Dr. VON BRAUN. Sir, I believe the very idea of extending our field of activity—I am talking of mankind as a whole now—of extending our sphere of operations and activity beyond our own planet, the very scope of this idea holds so many possibilities that it is very difficult to exactly predict what will follow.

But I think it does not take much imagination to see that the impact of such a venture on mankind as a whole and on our civilization in particular, will be comparable to the discovery of America.

The CHAIRMAN. And particularly in the peaceful nations it will be of vital importance.

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. If you can elaborate on any question you are asked, it will be beneficial to us.

Do we have the equipment now to send an information gathering rocket today to the moon? Do you have the information? I am not talking about the facilities.

Dr. VON BRAUN. Sir, I mentioned the difficulty of hitting the moon, but if you have in mind shooting past the moon, the answer is yes.

The CHAIRMAN. Is mere weight of a satellite of importance in establishing a lead over a competitor?

Dr. VON BRAUN. Satellite weight is an indication of the progress attained in rocketry. From a scientific point of view more weight in orbit enables you to conduct all kinds of space research that would be denied to a competitor with a less powerful carrier rocket.

For example, we could not have launched a dog into orbit yet with the missiles we had.

The CHAIRMAN. What is the heaviest satellite we can place in orbit with our presently available rockets, if you can answer that?

Dr. VON BRAUN. I can say this much: if we use our basic IRBM carriers, Jupiters or Thors, as first stages, we could orbit payloads in the order of several hundred pounds. If we use ICBM's, once they are a little bit further along the road, we can orbit payloads of well over a thousand pounds, several thousand pounds.

The CHAIRMAN. To explore and learn about the moon, is it necessary that a man be sent to that planet?

Dr. VON BRAUN. I think it is not necessary on the first try. In fact, it is most unlikely that on the first try a man will go along. But I think it is equally unlikely, after equipment has been successfully landed on the moon so that we can obtain information radioed back from the surface of the moon, that man can be held back much longer from going there and seeing for himself.

The CHAIRMAN. I have three more questions. I will just ask them and I am asking each one of you gentlemen, in looking over the testimony, or editing as we call it, to then consider them and answer them.

(1) What commercial utility do you foresee for long-range, point-to-point rockets?

(2) What commercial utility do you foresee for orbiting satellites?

(3) What military utility do you foresee for orbiting satellites?

There is no need of answering now because I realize that requires some consideration and thought. I know you can given an extemporaneous answer, but I would rather you gave a prepared answer because these hearings will be printed.

(Material referred to is as follows:)

Following are answers to questions posed by chairman of House Select Committee on Astronautics and Space Exploration to Dr. von Braun.

Question 1. What commercial utility do you foresee for long-range point-to-point rockets?

Answer Reusable rockets carrying high priority cargo, including mail, over long distances to an exact location are a distinct possibility Delivery of emergency items to out-of-the-way locations can be handled expediently by rocket. Also, the time is not too far off when man himself will be transported quickly and safely over great distances by rocket.

Question 2 What commercial utility do you foresee for orbiting satellites?

Answer An orbiting satellite with appropriate electronic gear can act as a communications station for truly rapid communication with any part of the earth At an altitude of approximately 22,000 miles, 3 orbiting satellites can effectively cover sufficient portions of the earth so that television may be transmitted and received between any 2 points on the surface of the earth. Later on, as manned space flight becomes a reality, these extraterrestrial stations will serve as communication links between the space traveler and earth. Large orbital space stations will be established to accommodate the space traveler.

Question 3. What military utility do you foresee for orbiting satellites?

Answer Orbiting satellites will provide a platform for global surveillance (i. e., detection of ICBM launchings, satellites, etc), for redefining the shape of the earth and determining the exact locations of land masses, oceans, cities, etc. Transmittal of high-priority military messages could be handled without interference by a specially designed communications satellite. Large satellites will serve as logistics centers and jumpoff points for combined scientific and troop expeditions to the Moon, Mars, Venus, and beyond

As I stated in testimony before the committee, I believe that satellites can be effectively used as weapons platforms in time of war. I disagree with one of the conclusions of one of Dr. Killian's reports which makes a premise to the contrary.

(NOTE —Part of the answer to this question is classified secret)

The CHAIRMAN There may be other questions that members might want to ask to have you gentlemen consider upon reflection and to answer in editing your testimony.

The fact is that it is vitally important that we always be in a position where we are capable of deterring, and I do not like the word, through the method of retaliation. Is that correct?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. In the immediate foreseeable future that is one basic consideration we cannot escape; is that correct?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. Do any of you gentlemen agree with that, Dr. York and also Dr. Merkle?

Dr. YORK. Yes.

Dr. MERKLE Yes, sir

The CHAIRMAN. We would like to have you in your editing put your background in the record. While it is not necessary for us, it should be in the printed record.

I have to leave. I am acting Speaker, so you gentlemen will excuse me. I will leave the committee in charge of Congressman Brooks as acting chairman.

When you recess may I suggest that you recess until 2 o'clock.

Mr. BROOKS (presiding). Are there any further questions?

Mr. HAYS. Dr. von Braun, pursuing the question that Mr. Brooks asked you, are you getting sufficient support?

I refer to the development of new fuels, propulsion systems and new materials, more emphasis is needed in these fields.

Dr. VON BRAUN. There is much going on in these fields. I would say there are three main problem areas:

One is the development of more powerful rocket engines, engines of more thrust. This development is based on conventional methods, and conventional fuels. It is, in essence, a scaling-up of a proven technology.

Secondly, there is the development of rocket engines utilizing more advanced propellents and propellent combinations, and the development of nuclear rocket engines. This is a pioneering job, in which it is a bit more difficult to pin down exact target dates for the completion of the task.

Mr. HAYS. You refer to bombing capabilities of a space vehicle. The President's Advisory Committee reports stressed that there was not a bombing capability from space. I say this for clarification.

Dr. VON BRAUN. I find myself in disagreement with the President's Advisory Committee on this point.

Mr. HAYS. You do not agree with their statement?

Dr. VON BRAUN. No, sir, I do not agree on this particular point.

Mr. HAYS. I have seen public statements that the Russians sputnik rocket had a thrust of several hundred thousand, or a million pounds.

Question No. 2 in that case, the case of Sputnik No. 2, the statement has been made that it was heavier than the Russians indicated; is that correct.

Dr. VON BRAUN All I know about that is what I just read in the papers, myself, sir. I am in no position to comment on that question at this moment.

The much greater weight now credited to Sputnik No. 2 seems to be a conclusion by the Smithsonian satellite tracking group. In analyzing the gradual decay of its orbit this group apparently found that Sputnik No. 2 stayed aloft longer than they had predicted on the basis of the 1,280 pounds weight which the Russians had mentioned.

So they suggested that Sputnik No 2 may have been heavier than the weight given by the Russians. How sound that conclusion is, I am in no position to say.

Mr. HAYS. It would be difficult under present circumstances to shed much light on that, I suppose. I suppose that would be difficult under present circumstances for us to determine with accuracy?

Dr. VON BRAUN. Yes, sir.

Mr. HAYS. Thank you, Mr. Chairman.

Mr. MCDONOUGH. Have we obtained more scientific information from our satellites? Are they better equipped than those the Russians up to now have put into orbit?

Dr. VON BRAUN. Sir, the Russians have not published the results from their sputniks yet. Under the agreement between the nations participating in the International Geophysical Year all participants are to supply the world with the results of their satellite firings 8 months after the firing itself.

Even for Sputnik I, these 8 months have not elapsed yet. But there are indications that the Russians will publish a report on both sputniks.

Only after studying these reports will we be in a position to say what they really learned. Of course, they may not tell us the whole story, but only part of it.

Mr. MCDONOUGH. How much pertinent information have we obtained from the satellites that we have placed in orbit?

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Dr. von Braun. I can speak only for our two Explorer satellites. Both have been very successful. They have actually supplied us with all the information that they were designed to furnish.

Explorer No. III in particular, which at first did not look so good, turns out to be a real bonanza so far as scientific information is concerned.

The very fact that it has an unusually high spread between lowest altitude and highest altitude, gives us much more information than we had originally hoped for.

In addition to this, Explorer III is equipped with a tape recorder which records cosmic-ray information during the entire orbital flight around the earth. This tape is played back (upon the receipt of a coded signal from a ground) to whatever receiver station just happens to be underneath the satellite. To "interrogate" Explorer III, this station transmits the playback command to the satellite.

In this fashion we get approximately 100 times more information out of Explorer III than we got from Explorer I.

Mr. McDonough. And you continue to get it?

Dr. von Braun. We continue to get it. The cosmic ray people involved in the Explorer III experiment have made some discoveries that were quite unexpected.

Mr. McDonough. Does the fact that we shot our satellite to a greater distance away from the earth indicate that we used greater thrust in takeoff?

Dr. von Braun. No, sir. You can always trade payload capability for altitude.

In other words, the lower the orbit the more payload you can put in the nose of a given rocket, and the higher any given rocket is to go, the less payload weight it can carry. With the thrust that the Russians must have had in their Sputnik II rocket, they could certainly place several hundred pounds of payload on the moon, which we could not do with any of our flight-tested rockets.

Mr. McDonough. Now, the greatest distance we have shot a satellite from the earth is what?

Dr. von Braun. I think the highest altitude attained by any man-made object so far was reached by Project Farside of the United States Air Force. Farside was a balloon-launched, unguided, multi-stage, solid rocket. So far as I know, it lost radio contact with the ground at about 2,500 miles altitude, and the thing was still climbing at that time.

Mr. McDonough. That did not contain any scientific apparatus to give us any information?

Dr. von Braun. There was some measuring equipment in the nose, but they lost radio contact at about 2,500 miles altitude.

Mr. McDonough. That did not go into orbit, though?

Dr. von Braun. No, sir; it was not meant to.

Mr. McDonough. Does the apogee indicate that that is the most distant point when you shoot it away from the earth? When does a satellite start orbiting and at what distance and why does it go farther away after it has gotten into orbit?

Dr. von Braun. In order to orbit, an object has to go fast enough in a horizontal direction so that the centrifugal force caused by the curvature of the trajectory is strong enough to cancel the gravitational

pull of the earth. If centrifugal force and gravitational force cancel each other exactly, the result is a circular orbit.

When the object attains a somewhat higher velocity, then you get an elliptic orbit, a kind of egg-shaped orbit, and the highest point of such an elliptic orbit is called the apogee and the lowest point is called the perigee.

Mr. McDONOUGH. Is the apogee the point at which it starts to orbit when it leaves the earth?

Dr. VON BRAUN. No, sir; it orbits all the time. An elliptic orbit simply is not a perfect circular orbit, but an orbit with distinct high and low points.

Mr. BROOKS. Mr. Fulton.

Mr. FULTON. The question comes when we get beyond the means of travel we are speaking about now. What are the limits to which we can go?

For example, we are talking of speeds that are from 18,000 to 25,000 miles an hour on the orbiting phase. When we get beyond the phase of orbit, then we are talking of a different field entirely.

May we just put our minds to that for a minute. You have said, I think, as one of the classic understatements of the year, the universe is quite a big place, and that is right. The question come up what are the outer limits? We are talking of this kind of speed. We are talking of speeds that originate on the earth or in relation to the earth's timing or calendar.

Suppose we move out of that sphere into the universe, beyond gravity, beyond the atmosphere and beyond the atmosphere of any planet. Then the question comes on the maximums of speeds, on the speed of light, 186,300 miles a second.

Do you think that we on our approach to the universe, when we think of it as extending millions and tens of millions of miles, do you think we can look ahead to speeds that can approach the speed of light and if that is so, is the speed of light the limit?

Do you agree with Einstein, when you hit the speed of light you are done?

Dr. VON BRAUN The speed of light is a definite upper limit in the sense that no object can exceed it. For a body traveling at the speed of light time does not pass This means that the speed of light is the highest speed theoretically attainable.

Mr. McDONOUGH Is that attainable or conceivable?

Dr. VON BRAUN. Attainable.

Mr. FULTON. Do you agree with that?

Dr. VON BRAUN There is no argument on that point in the scientific world. It is a generally accepted fact.

Mr. FULTON. You feel that as we approach 186,300 miles per second that is approaching the highest speed attainable?

Dr. VON BRAUN. Yes, sir.

Mr. FULTON. Of course, Mr. McDonough made quite a point there, it is possible for me to think that I am going that fast and throw a baseball 20 miles an hour faster.

Dr. VON BRAUN. The time scale gets distorted as you approach the speed of light. If you travel at close to the speed of light, then time passes slower for you than for the people you left behind. So for you it still looks like the baseball is leaving you at the rate of

20 miles an hour, in the forward direction, but for the people left behind it still has not exceeded the speed of light.

Mr FULTON. Suppose I am approaching very closely the speed of light and throw a baseball ahead faster, now what would happen? I have done the impossible, at least in conception.

You see, there is a breakthrough on sound.

Dr. VON BRAUN. The inertia of mass increases also, as you approach the speed of light, and it would require an infinite amount of energy to accelerate an object beyond the speed of light.

That is why it is physically impossible to exceed the speed of light.

Mr. FULTON. That is your maximum of speed. What is your termination on distance? Where does the universe end to you? How far can we go in space?

Dr. VON BRAUN. I think for the practical purposes of astronautics and space flight it would be a good idea to limit our thinking to the solar system, at least for this and the next few generations.

Mr. FULTON. Now, we talked of the practical and we talked of the concept. You think of the universe as a wheel and we can only go so far in one direction and we find ourselves coming back.

Dr. VON BRAUN. Yes, sir; This is quite correct. But I do not believe that this is a consideration of any practical importance for space travel, simply because the travel times involved would be far in excess of the lifetime of a human being.

Mr FULTON. Yes; but if you bring the speed up to approaching the speed of light, we are talking of a very different concept.

I believe you were the one who said, "Please don't make the programs limited for military end use, keep your mind open and broaden it."

Now, when this committee shows it is pretty broad, you are the first one to say "No."

Dr. VON BRAUN. I am sorry, it may well be that five generations from now people will say I was very narrow and old fashioned in my concepts of space flight

Mr. FULTON. Should we hire another superspace scientist then?

You see, the question is where does your field end You have spoken, according to Mr. Brooks, of 60,000 feet as the beginning of space. Where is the practical area, both on speed and on distance where this committee should limit its phases?

You see, I am setting the outer reaches and, of course, we come to a point where we look at the practical against the concept.

How far should we speak of on this committee? What is the limit of our jurisdiction?

Dr. VON BRAUN. I do not see why you should set yourself a limit at all. Why don't you just say the sky is the limit, or infinity is the limit

I just do not believe that in the foreseeable future manned travel beyond the solar system will be a practical consideration because the traveling times are so long.

Even if we had power sources to travel at speeds close to the speed of light it would take about a year to build up our cruising speed without crushing the crew members by the acceleration that is necessary to build up to that speed. And this full year would be needed solely for the first departure maneuver.

Mr. FULTON. For all practical purposes then what do you set as the speeds and the space limitations on this astronautic approach or a national plan for astronautics? What is your limitation?

You see, we must set the field. Mr. Brooks very adequately pointed out the lower limits. I am now taking the upper limits and the speed limits. Where should we set the field?

Dr. VON BRAUN. You really feel you must set a limit?

Mr. FULTON. Where we are considering our abilities in this country and our scientific capabilities and likewise the expense, should we set the field?

Dr. VON BRAUN. If you desire to set a limit I would suggest you take the boundaries of the solar system, and leave it to future Congresses to amend the act if necessary.

Mr. FULTON. Would you not limit it to the planetary system?

Dr. VON BRAUN. Yes, sir.

Mr. FULTON. The moon, Venus, Mars?

Dr. VON BRAUN. I would include even the remotest planets, Uranus, Neptune, Pluto.

Mr. FULTON. Thank you very much.

Mr. BROOKS. I will say to the members of the committee it is now after noon. The committee will reconvene at 2 o'clock.

I want to call on counsel, but Mr. Ford tells me he will be at the committee at 2 o'clock.

If it is the pleasure of the committee we will hear from Mr. Ford.

Mr. FULTON. Could I furnish questions to the record for the gentlemen to answer?

Mr. BROOKS. Without objection they will be placed in the record.

(The material referred to is on file with the committee.)

Mr. FORD. Dr. von Braun, am I correct in assuming that the V–1 and V–2 rockets are the father, so to speak, of the Redstone, Jupiter-C, and your Jupiter? Am I correct in that assumption?

Dr. VON BRAUN. Well, the V–2 was the first large liquid fuel rocket that was successfully demonstrated; yes.

Mr. FORD. When in your opinion did you father the idea of a satellite using Jupiter-C or its predecessor, the Redstone, or the V–1 and V–2, when did this concept of a satellite come into being, so far as you are concerned?

Dr. VON BRAUN. I think that concept is pretty old. It was suggested in books as early as the 1920's.

Mr. FORD. When did you first feel that there was a hardware capability of getting a satellite into orbit?

Dr. VON BRAUN. We submitted the first proposal for building a satellite based on the Redstone missile in the summer of 1954.

Mr. FORD. Had there been a concept developed that could have been feasible prior to that time?

Dr. VON BRAUN. Sir, this question always comes back to what hardware was really available and suitable for the job. Many artist's conceptions of minimum satellites had been proposed in the trade journals. But our proposal in 1954 to which I was just referring, while it was very modest in scope, had the distinction that it was exclusively based on rocket hardware that was really available and proven at that time.

In this respect alone it was unique.

Mr. FORD. Based on using the Redstone hardware?

Mr. VON BRAUN. The Redstone, and also the solid rockets proposed for the top stages were available at that time.

Mr. FORD. Was this concept predicated on the hardware which at that point was actually available or practically available?

Mr. VON BRAUN. Yes, sir.

Mr. FORD. If the Redstone hardware had been available at an earlier date, would this concept have been feasible at an earlier date?

Mr. VON BRAUN. Yes, sir.

Mr. FORD. In other words, the breakthrough in the Redstone hardware was the crux of the matter so far as an operational program was concerned?

Mr. VON BRAUN. Yes, sir.

Mr. FULTON. May I have one more question?

Mr. BROOKS. I agreed to recognize one of these gentlemen on the right here.

We will now recess until 2 o'clock. Can you gentlemen all be here?

Dr. YORK. No, sir.

Mr. FELDMAN. We have Dr. York coming at a later date in any event.

Dr. YORK. I explained to Mr. Feldman this morning that I could be here this morning.

Mr. BROOKS. This committee will recess now until 2 o'clock.

(Thereupon, at 12:15 p. m., the committee was recessed, to reconvene at 2 p. m., same day).

AFTERNOON SESSION

The committee reconvened at 2 p. m., upon the expiration of the recess.

The CHAIRMAN. The Chair understands that Dr. York has an appointment about 3 o'clock or thereabouts and arrangements were made before the luncheon recess for Dr. York to testify upon the committee's reconvening.

Dr. von Braun will step aside temporarily so that we may hear Dr. York.

We are very glad to have before us another dedicated American who is playing a very important part in the troubled world of today, Dr. Herbert York, who is the chief scientist at ARPA.

Of course he has many other qualifications which he will put in the record.

We are very glad to have you with us today, Doctor.

STATEMENT OF DR. HERBERT F. YORK,[2] CHIEF SCIENTIST, ADVANCED RESEARCH PROJECTS AGENCY

Dr. YORK. Thank you sir.

I do not have any statement to make because my being here was only arranged this morning. I shall be glad to answer questions of the same type that Dr. von Braun answered or anything else that the committee wishes to put to me.

The CHAIRMAN. Have you read the bill?

[2] York, Dr. Herbert F(rank), Radiation Lab, University of California, Box 808, Livermore, Calif. Physics. Rochester, N. Y., Nov. 24, 21; m. 47, c 3. A. B , Rochester, 42, M S. 43, Ph D , California, 49. Teaching asst., Rochester, 42–43, physicist, Radiation Lab, California, 43–45, asst. prof. Physics, 51–54, Assoc. Prof , 54—, Director Livermore Lab, 54—, Mem Air Force, Sci. Advisory Board With Atomic Energy Comm, 46. Physical Soc. Atomic physics; electro-magnetic isotope separation, scattering 90 mev neutrons.

Dr. YORK. I read it a few weeks ago.

The CHAIRMAN. Have you any comments to make about it or any parts thereof?

Dr. YORK. I have a comment of a kind perhaps, and that is that insofar as the bill makes positive statements about the NASA, I think it is all fine.

It wants to strengthen the NACA in its mode of operations and so forth.

There have been statements, though, in connection with it—I am not sure that it is in this version or not—that have said that the Department of Defense should do only those things which are associated with well-defined weapons programs.

I think one of the difficulties in the past has been that the department has not done all that it might have done in connection with programs, that there was a reasonable confidence that requirements would arise, and it often waited too long in order to have a specific and well-defined requirement come up.

That, as much as anything, is the reason that we are behind the Soviet Union today in this space work and in the missile work, too.

The Soviets began the development of big rockets just because they intuitively knew that big rockets were going to be useful.

We did not begin the development of big rockets here until after the hydrogen bomb had been perfected and until we could lay down a well defined requirement.

One of the reasons that ARPA was set up—and named the Advanced Research Projects Agency—was to anticipate reasonable requirements.

For example, in the case of the million-pound engine, there is no well-defined requirement. If we were limited by law to somehow being allowed to only work on things which have well-defined and specific requirements we could not work on a million-pound engine, yet everyone agrees that is a good idea; people in the space program, people in the Department of Defense, the Johnson committee has put it as one of its 17 points and so forth.

It is the kind of thing we would go ahead on because it represents the next big step down the road. It represents progress, if you will.

But there is no well-defined requirement for one, so that I take exception to any statements that we should only work on things for which there is a well-defined requirement.

The CHAIRMAN. Without authority, too? What was your last observation?

Dr. YORK. The bill designed to establish NASA should not have language in it which says we can only work on things for which there is a well-defined requirement—we in ARPA, in the Department of Defense.

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. What you really mean, Doctor, is that there should be pure scientific research as well as applied scientific research?

Dr. YORK. Yes. I would not make the distinction so much on the difference between pure and applied in this case. It is just that when reasonable men can agree that there is a logical next step, and this is a good example, a million-pound engine, one should go ahead with it and not wait until it has been analyzed to death and until every last possible person is convinced that there is something which you can call a specific requirement or well-defined requirement.

If we had adopted that attitude in the late forties, we would have these big missiles available today.

Mr. BROOKS. In reference to these larger engines why did we not proceed to develop the intercontinental ballistic missile and use that type of engine in the satellite program?

Instead, we proceeded with a smaller and more delicate engine.

Dr. YORK. Now we are doing that. Now we do have plans to apply our IRBM engines to the space program. When the ICBM engines are available we will apply those to the space program.

Mr. BROOKS. Then you will be able to use them alternately for a space program or for practical military purposes?

Dr. YORK. Yes. The developments of these engines and in fact not just the engines, but the whole rocket system, are expensive developments and they should be used for as large a variety of purposes as are decided important.

Mr. BROOKS. Do you call the intercontinental ballistic missile an outer space missile?

Dr. YORK. I would not call it an outer space missile when it is actually used as a ballistic missile. It is true, it traverses outer space, but I think it is useful to think of outer space vehicles as being those which stay up there for a little while, more than just 30 minutes, such as an ICBM does.

If you just change the programing, a two-stage ICBM could be used for launching satellites. It does not even need a third stage.

Mr. BROOKS. Of course, I think we are blazing a trail and in the mind of the public it is neither inner space nor outer space, or a space missile.

It is whatever we denominate it at this time.

Dr. YORK. Yes, sir; it is just a matter of words, really. It can be the same set of engines and guidance and so on that can be used either for a missile or space vehicle.

Mr. BROOKS. It would affect the jurisdiction of this committee considerably because were it considered a space missile, then it would come within the range of this committee.

If it is not considered a space missile, it may not come within the range.

Dr. YORK. Just as a handy working definition in our program we do not consider it a space missile, but that is a matter of our own convenience.

The CHAIRMAN. How high does an intercontinental ballistics missile go into space in its journey?

Dr. YORK. When used as a missile it goes about 600 or so miles in the air.

If you pointed it straight up and kept the same payload on it, it it would go about 3,000 or 3,500 miles.

If you take the payload off, it goes 4,000 miles.

As a missile, though, it only goes up 600 miles.

Mr. BROOKS. And it can be used alternately as a missile or satellite?

Dr. YORK. Yes, sir; I am sure it will be.

The ICBM's, I am certain, will become the backbone of our space program in the early Sixties.

Mr. BROOKS. Why did we lag behind in the development of the ICBM? Surely there was a practical reason for development of that?

Dr. YORK. I think one of the main reasons we lagged in the develop-

ment of the ICBM is that we waited to begin the development of big rockets until after it could be proved to everybody rather than just to reasonable men, that big rockets were important missiles.

I mean that in my opinion it should have been obvious in the late Forties that we should get on with this job, and that there would surely be use for one, but we did not. We waited until after the warheads had been developed. Whereas it is quite evident the Russians did it the other way around, they developed the missile, then they developed the warhead.

Mr. BROOKS. Did we take full advantage of the secrets that we obtained from the Germans in World War II?

Dr. YORK. No; if we had we would have the ICBM today.

Mr. BROOKS. So it is just negligence and failure on our part to give the program the proper punch that keeps us now from having the well-developed ICBM?

Dr. YORK. It was waiting for a well-defined specific requirement to arise that kept us from having it today.

Mr. BROOKS. In reference to our scientists, you are an American-trained scientist?

Dr. YORK. Yes, sir.

Mr. KEATING. Will you yield there for me to say he was trained in the University of Rochester originally.

Mr. FULTON. Is that in your district?

Mr. KEATING. That is right.

Mr. Chairman, will you just excuse the interruption

The CHAIRMAN That is nativistic pride.

Mr. BROOKS. We will overlook the colloquism there

But let me ask you, generally speaking, do you find in your work that scientists are short in their training or fail in some respects in the training they have received at American institutions over and above that which they should have?

Dr. YORK. I think that in some of the theoretical aspects of science they could have more than they do have. The Europeans in general, and the Russians in particular, do seem to have a heavier emphasis on certain theoretical fields than we have today

I think that when those of us who are concerned about American education make something of it, what we are talking about is not so much the question of availability of scientists and engineers in the United States and Russia today; it is when we conceive of the situation 10 years from now that it looks kind of glum.

Mr. BROOKS. What do you mean in reference to the superiority of the Russians in reference to certain types of scientific training?

Dr. YORK. I think even today at the Russian schools there is more emphasis on theoretical work, in fact on hard work in general, than there is in the American schools

Mr. BROOKS. Ours is more applied science, even in schools?

Dr. YORK. Yes; I guess you could say that.

Mr. BROOKS. That is all, Mr. Chairman.

The CHAIRMAN. Mr. O'Brien.

Mr. O'BRIEN. Dr. York, you mentioned our lag was due in part to the lack of specific well-defined requirements.

Dr. YORK. I think we should not wait for those.

Mr. O'BRIEN. I was wondering if within the terms you employed you believe there is a requirement now for a manned or unmanned space vehicle?

Dr. YORK. That falls in almost the same category perhaps as the million-pound engine. You cannot in the military sphere at least come up today and describe what you would call a well defined specific requirement for man in space. That belongs in the same category of things with a million-pound engine in my opinion.

It is something that we should get busy on and have a firm solid program to achieve a man in space because we know intuitively or we think there is a reasonable chance there will be a requirement for man in space and so let us go about it in a deliberate way rather than wait until the requirement arises and have a crash program 2 years behind the Russians.

Mr. O'BRIEN. There is not such a program now?

Dr. YORK There is the beginning of such a program and we hope to expand it considerably next year.

For example, the Air Force has a large air-space medicine program. The Navy has a small one. The Army has done some work in it.

There are quite a few studies in progress, both Government financed and also privately financed, on manned space vehicles.

There is not really an aggressive program going now, but we are in hopes there will be before too long.

Mr. O'BRIEN. I was very much impressed this morning with Dr. von Braun's suggestion that we should discontinue our unfortunate practice of supporting only such research and development that serves immediate military objectives.

I assume that he had partly in mind the scientific advances that will be very valuable in a peaceful way.

Dr. YORK. Yes; but in military, too. I think I am saying the same thing he was saying, but in somewhat different words.

I am fighting against the requirement for a well defined requirement.

Mr. O'BRIEN. I would assume that any advance, even if it were for peaceful purposes, could be used for military purposes.

Dr. YORK. Not just any advance, there certainly will be some which do not have military applications, but I am certain that there will be a great many that do.

That has been the history of science all along.

Mr. O'BRIEN. I understand the urgency of the military aspects of this problem. I know there will be great emphasis on this committee on certain peaceful uses of this knowledge.

Do you think that it will be reasonable to hope, in the light of what we know, that it might be possible one day to put a caravan vehicle of cargo in the sky over New York City and deliver it 20 minutes later in London? I have heard that statement made.

Dr. YORK. It certainly would be possible.

I am not prepared to answer the question as to whether it will be something useful, but it certainly will be possible.

Mr. O'BRIEN. In the field of communications it has been suggested that with this advanced knowledge we may be able to eliminate this great mass of wires we have that seems to stagger or fall whenever we have a series of storms.

Dr. YORK. Yes. There is quite a bit of enthusiasm among the people in the program in that particular field. The idea of using satellites as relay stations is one that we are planning in ARPA on working on quite strenuously next year.

In fact, there are all sorts of ways to do it. There are all kinds of questions to be answered. It is something we want to have some time to study first and then get an active program moving.

But that is one of the earliest places where one can hope for a practical payoff in space technology.

Of course, that has both civil and military interests.

Mr. O'BRIEN. Entirely peaceful.

As Dr. von Braun said, you would have to protect the skyways just as you had to protect the freedom of the seas. There were two other fields mentioned.

The question of scarce resources, we might arrive at a point in this planet where certain resources we need to acquire might become very scarce, it might be possible to obtain resources from other planets.

I realize that is considerably in the future.

Dr. YORK. That is very long range; yes.

Mr. O'BRIEN. Finally, genetic information; is that a strong possibility, too?

Dr. YORK. I don't know whether genetic information is quite the right word, but biologic information is. There is very much of an enigmatic question, a great teaser, whether for instance, there is life on Mars.

Personally I feel just answering that question, finding out that there was—well, I don't know; it would double what we know about biology today. We would know life had a good chance of springing up whenever there is a chance for it, which is something we still have to argue today.

If that is what you meant, I think space can have a tremendous impact biologically.

Mr. O'BRIEN. Dr. von Braun feels and you feel we need a long-range program; we cannot have this hit-and-miss business we have had sometime in the past.

I just raise these questions, thinking in terms of public support for substantial appropriations that might be necessary.

I have one last question.

Dr. von Braun said that NACA has been an advisory agency for the most part. You suggest a need for a decision-making group to set requirements. Do you not think that NACA as such would need to change its role to meet that need?

Dr. YORK. NACA would need to be changed in order to operate effectively as NASA. It has not been just solely an advisory committee for the last few years. It does not do much in the way of actually producing pieces of hardware for flight testing. It would have to acquire that capability, but NACA provides a good mechanism to build NASA on.

I prefer to think of it that way, that NACA is an existing nucleus of people on which you can now build NASA.

It is not so much as to convert NACA into NASA as to use it as a nucleus with which to proceed.

Mr. O'BRIEN. Thank you very much.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Dr. York, as you know, in establishing a national space exploration program we have many problems to decide and solve. One matter that Dr. von Braun brought out this morning

was that here in this country we are peace-loving people and we have a tendency to become very quiet and peaceful to say the least, and we do not move forward as we should.

At this particular time, Dr. York, in your opinion, should we have a crash program or what type of program should we have to get this program on the way?

Dr. YORK. I would rather have a strong deliberate program than a crash program, a program about which I could use the identical words that Dr. von Braun used this morning.

I am more concerned about a strong and continuous program than I am about a crash program that builds up and then collapses downward again

Because in order to keep good people in an organization you have to keep the organization going steadily. Every time you build it up and then let it contract, the good people leave. Then you build it up again and you get a mixture in on top of the poor ones who have stayed; if you "breathe" a few times like that pretty soon you don't have a good organization any more.

It is continuity and deliberation that are worth something here.

Mr. NATCHER. Dr. York, are you satisfied in your own mind we are proceeding at the proper pace today?

Dr. YORK. Today we are in a transition period. We are still trying to get a good program going. I think it will sort of depend on what comes out of the Appropriations Committee and things like that.

We in ARPA are coming in with a program that is certainly substantially bigger than the program that has been going on.

It could, of course, be bigger. It is hard for me to judge what is the right size, but we certainly are planning a program that is bigger than now exists

Mr NATCHER. Dr. York, if not a crash program, should we not have a program that is speeded up considerably in order to overcome this lag we have? We all admit we are behind. So why not speed it up some?

Dr YORK. The space program per se will be speeded up. The missile program from which the vehicles will come that satisfy the space program has been on a crash basis or virtually on a crash basis now for several years

Our program in ballistic missiles, in ICBM's and IRBM's, is a good, strong program and a very large program, a program that has lots of people, lost of plans, lots of money and so on.

We are behind because we started so late and not so much because we are not working hard right now.

The CHAIRMAN. Are we making progress?

Dr YORK. We are making real progress.

Between the Air Force in its ballistic missiles division and the Army in its ABMA, there is a great deal of progress being made

I hope we are catching up in this particular field, but we are so far behind because we started so late.

Mr. NATCHER. In order to catch up, as I understand, you believe this program should be speeded up?

Dr. YORK. Yes.

The CHAIRMAN. Supposing we do not catch up, what then?

Dr. YORK. It is hard to know, I would have to be a future historian to know the consequences of that. But I would not like it, I am sure.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Dr. York, when in your own mind were you convinced we had fallen behind Russia in space exploration and in the development of the IRBM, the ICBM, or in basic research, or in the whole field?

Dr. YORK. I don't think we are behind in basic research. We are in danger of falling behind, but I don't think we are behind in basic research, taking basic research as a whole.

In missiles, I don't remember when I first began—it is one of those things that I eased into gradually—to realize that we were behind.

I know, though, it was before the sputniks, but I don't remember how much before.

Mr. SISK. In view of many statements which have been made, and some of them are a little bit contradictory. I am rather interested in knowing how long you have been connected with the satellite program, with the IRBM and ICBM program.

Dr. YORK. I have been growing into it for about 6 years.

Mr. SISK. As I understand it you, you do not think we are behind in basic research.

Dr. YORK. Basic research, taken as a whole, meaning physics, chemistry, biology, and so on, even in the question of what it takes to make an engine, I don't think we are behind.

Where we are behind is in applying this research to missiles in space. We are behind in technology, not in basic science.

Mr. SISK. In other words, we are moving ahead in basic research and the basic sciences?

Dr. YORK. Yes.

Mr. SISK. Well along with the balance of the world, or ahead?

Dr. YORK. We are ahead with the Russians coming up fast.

Mr. SISK. You feel we are likely to apply the knowledge we have learned in actually putting vehicles into being; is that correct?

Dr. YORK. Yes.

As has been said by Dr. von Braun earlier, and many others before that, we could have begun the ICBM program many years earlier. We had the basic science, if you want to call it that, available immediately after the war. We did not use it.

Mr. SISK. Was it necessary, Dr. York, to do a lot of development to develop basic science before we were in a position actually to motivate an instrument?

Dr. YORK. We had to do a lot of development work, engineering development and technological development.

I think actually we are just concerned here with the definition of basic research which means different things to different people. We had to do development, we had to do engineering; we had to do some exploration, something in between basic research and engineering.

But the basic research was available years before we tried to use it.

Mr. SISK. The point I was driving at is that according to statements by others; in fact, General Medaris indicated that some of the research and development done by Dr. von Braun and his team from 1945 right through until, for example, their firing of the Redstone, I believe, in 1953, was necessary to the development of the program which we today are so much interested in.

I am a little bit curious. That is why I asked you when in your opinion we fell behind. There seems to be some contradiction of where we are behind and in what field.

Dr. YORK. We fell behind as soon as they started working on bigger engines than we were working on. That must have been in the late forties.

Mr. SISK. In other words, you feel we had the knowledge to build better engines, but because we did not put the money into it, that Congress did not appropriate the money——

Dr. YORK. We had the basic scientific information necessary to build the engine, build the guidance equipment and so forth. There is much more to a rocket than just propulsion which is where we seem to be putting all our emphasis today. That is just one component.

Mr. SISK. We have to have something to go with the thrust engine. In other words, the thrust engine alone would be worth nothing to us unless we had some research information, which, as I say, I was most concerned about, and it was my understanding that a great deal of this information was being developed during the years that actually led to where you are today.

Dr. YORK. Of course, today is a reflection of everything that happened in the past. The things that are new are more technological than they are basic science.

The CHAIRMAN. I have heard a lot of evidence that there is not enough emphasis on creative research.

Dr. YORK. There is not for the future, but in this particular program of building an ICBM, the information on which our ICBM's are being built was available long before the missiles were started.

The CHAIRMAN. You are confining yourself to ICBM?

Dr. YORK. To big rockets, whether it is ICBM's or space vehicles.

Now, we should be doing more basic research today than we are doing so that 5 years from now we will have still better ICBM's.

Mr. SISK. I just want to conclude, Mr. Chairman, with this one question.

The CHAIRMAN. I am not stopping you.

Mr. SISK. I appreciate that, Mr. Chairman.

The CHAIRMAN. This is a sort of family affair.

Mr. SISK. Dr. York, I realize this is repetitious in a way, but I still have not been able to get clear in my own mind, do you feel we have an opportunity to overcome the lead which Russia has in actually applying the research and development knowledge they have by 1960, by 1962, by 1965?

Assuming we proceed at an adequate pace?

Dr. YORK. I don't think we can catch up with them in the field as a whole by 1960; that is, in the rocket and space field as a whole we cannot catch up with them by 1960.

We certainly can catch up with them; the opportunity exists, it is just a matter of putting our backs to it.

Mr. SISK. I am not sure I understand everything you say. Do I understand that you say we can catch up; it is just a matter of putting our shoulder to the wheel?

Dr. YORK. The opportunity does exist. There are enough people in this country; there are enough facilities. We could catch up, but not by 1960. It is too late to catch up by 1960 now.

Mr. SISK. I feel there has been a doubt present in your mind. Do you believe that we are going to catch up?

Dr. YORK. I did not understand that to be the question. I said we could catch up. Whether we are going to or not is a matter of

decisions that are to be made here about how hard we are supposed to work on this program.

Mr. SISK. I think we are primarily interested in what we must do—I am speaking of the Congress—what must we do because I maintain we cannot afford not to catch up. We must catch up and we must surpass or in my opinion we will cease to enjoy life as we understand it.

Dr. YORK. I agree. I am anxious to catch up with them, myself.

Mr. SISK. That is the point I want to bring out, what you think we should do to catch up.

Dr. YORK. Work harder.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Dr. York, you mean if you are given the tools and the implements and the funds we can catch up with them?

Dr. YORK. We have the tools but we need the funds and the go-ahead and so forth. I mean all the technical people now. I was not speaking really for ARPA. I mean we technical people just need to go ahead with a program that is deliberate.

Mr. McDONOUGH. When you say we are not up to them, do you mean that they have the implements, the implementation, they have the facilities for putting into operation some of this basic science we are not doing?

Dr. YORK. They must. The evidence is they have a whole family of missiles right on up to the ICBM's, so they must have the facilities for doing it.

Mr. McDONOUGH. We know that?

Dr. YORK. Yes.

Mr. McDONOUGH. And in quantity, you mean?

Dr. YORK. Well, they have done the job. They must have had the facilities for doing it.

Mr. McDONOUGH. You are talking about military facilities?

Dr. YORK. Yes, except that a big rocket booster used for a satellite is not different from a big rocket booster used for a ballistic missile. It actually is a bit easier to put up a satellite than it is to build a ballistics missile.

Mr. McDONOUGH. You were speaking about whether we could discover the presence of organic or vegetable life on Mars.

Can we discover that without sending a man to the planet?

Dr. YORK. It may be possible, but I am inclined to think we cannot. We can discover a great deal else without sending a man up there. I would hope that an important part of our space program will be sending out what you might call Mars probes, these are devices that contain cameras and other kinds of sensing equipment, sending them out to Mars to see what they can see.

But finding life is probably a little too difficult for machinery. We certainly could not find out much about it, even if we could find out whether it exists, or not.

Mr. McDONOUGH. Do we have any positive knowledge of the existence of life on the moon?

Dr. YORK. No. It is extremely dubious, that is all you can say. There is certainly no positive evidence and there is a great deal of reason for believing there is none.

Mr. McDONOUGH. Insofar as Russia is in this position you speak of, do you mean to say they are in a position of initiative where they can attack us successfully, subdue us now?

Dr. YORK. That depends on many more factors than just the question of, say, one particular weapon like the ICBM. I do not think they are in a position to attack us and subdue us now. On the other hand, they are headed that way and let us not have it.

Mr. McDONOUGH. Are you familiar with the tests that we are about to make in the South Pacific on the deterring of missiles by nuclear bombs?

Dr. YORK. Yes, sir; I am familiar with it. I am fairly familiar with it.

Mr. McDONOUGH. That is an advance that so far as we are concerned is ahead of Russia, is it not?

Dr. YORK. That is our belief, that in that particular field we are ahead of Russia.

Mr. McDONOUGH. In other words, in nuclear development we are ahead of Russia?

Dr. YORK. In nuclear weapons development we are ahead of Russia.

Mr. McDONOUGH. That is all, Mr. Chairman.

Mr. FULTON. We are glad to have you here, Dr. York. I might say to you that Lincoln made a pretty good President. He, I think, was educated with slate, was he not, not the University of Rochester?

Mr. McDONOUGH. He had a good brain, too.

Mr. FULTON. Yes.

Let me ask this: What is your position with ARPA?

Dr. YORK. I am Chief Scientist with ARPA.

Mr. FULTON. You have relations with the National Advisory Committee for Aeronautics?

Dr. YORK. We have good relations with NACA which we expect will turn into NASA.

Mr. FULTON. So on your relationships there are no disputes between agencies at the present time, are there, that are holding back the development of missile programs, weaponry or nuclear research?

Dr. YORK. There are no disputes between ARPA and NASA that are holding back any research of this sort; no sir. I am anxious for it to stay that way.

Mr. FULTON. All right.

The CHAIRMAN. Is there anything else beside disputes?

Dr. YORK. Nothing that involves these two agencies. We have incidentally, been working together for some several months on the question of what a space program ought to be for next year. We are already hand in glove with NACA.

Mr. FULTON. But you have this cooperation although there are at present questions on jurisdiction which must be by give and take; is that correct?

Dr. YORK. There are some discussions that are going on now about who is going to do what, yes, but in the meantime these discussions are not interfering with getting ahead with the program because until NASA is set up we are going ahead and doing what we think needs to be done insofar as we are able to do it.

Remember, that ARPA has only a $10 million budget in 1958.

Mr. FULTON. You spoke of the million-pound engine. Does ARPA have the physical facilities as well as the scientific personnel to handle a program of that size?

Dr. YORK. ARPA per se does not have the facilities or the personnel for handling it. What ARPA would do in a case like this would be to find within the existing missile industry and missile laboratory groups the capability and then have the job done there.

ARPA would not do this job itself.

Mr. FULTON. No, but you would supervise it in your view; is that not correct?

Dr. YORK. Yes.

Mr. FULTON. How much have you had so far on funds for the development of the million-pound engine, a half million dollars?

Dr. YORK. ARPA has not had anything. The Department of Defense has been putting that kind of money into it in the form of study programs.

Mr. FULTON. How much was it?

Dr. YORK. I don't remember for sure, but it is around half a million dollars per year for a couple of years.

Mr. FULTON. What do you think then it would cost to develop a million-pound thrust engine? What is the total cost of that?

Dr. YORK. The engine alone would cost somewhere between 130 and 200 million dollars. That is for an engine involving a single thrust chamber, with a thrust of 1 million pounds in 1 chamber.

A rocket would cost 2 or 3 times that much.

Mr. FULTON. So really, to get an engine and a rocket with a million-pound thrust of the type we are talking about the present rate of expenditure of a half million dollars worth of study funds a year allocated to ARPA by the Defense Department it would take 400 years, if it cost $200 million, would it not?

Dr. YORK. That is the way the arithmetic comes out.

Mr. FULTON. That is simply for the engine, not the vehicle.

Dr. YORK. This half million dollars a year has been for study programs to determine what to do. It is now the sense of the department to go ahead on an aggressive program for the million-pound engine provided somebody does not come along and say "You can only work on things for which there is a specific well defined requirement."

Mr. FULTON. Do you not think it will take a dollar or two more immediately to help you on that program for the million-pound program?

Dr. YORK. I think 10 or 20 million dollars for the next year would be about right.

Mr. FULTON. How long at that pace would it take you then to develop this million-pound engine?

Dr. YORK. There are two approaches to a million pounds of thrust. One approach is by building a single barrel engine which then, of course, you could group in pairs to get up to 2 million or 3 million, or what you wanted. That would probably take about 5 years.

I don't think you can do very much to shorten it. There is another way and that is to take other big engines which are under development which have a lower thrust, some few hundred thousand pounds—I don't think I should say how much—and put them together in groups. That could be done faster.

It is not as good a way to do it, but if there were an emergency reason for having a million pounds of thrust, one could do it now.

Mr. FULTON. How quickly would it take if we did it in stages as you say you could combine them and do it at various levels?

Dr. YORK This is taking 3 or 4 engines and putting them side by side.

Mr. FULTON. That is what I meant. Various engines, do it this way or however you want to hang them on, but how quickly could you do it on that kind of crash program if you wanted to develop fast a million-pound engine?

Dr. YORK. If you decided that was the route you wanted to take and that is something about which there is some argument, I would suppose you could do that in 3 years, something like that.

Mr. FULTON Is there research going on in the use of thermonuclear power so that we do not have to stick with these old liquid propellents and some of the solid propellents?

Dr. YORK. There is research in nuclear power as applied to nuclear rockets. That is what I believe Dr. Merkle is going to be talking about.

There is not much in the way of application of thermonuclear energy to rockets.

Mr. FULTON. How much money have you received on nuclear studies in ARPA through the Department of Defense?

Dr. YORK. ARPA at the moment is not in that field. We may get into it, but we are not in that field now.

Mr. FULTON. Who has the supervision of it?

Dr. YORK. It has been jointly handled by the Air Force and by the Atomic Energy Commission.

Mr. FULTON. When you consider on the present missiles the amount of extra equipment they have to carry, is there any research being done to eliminate that equipment?

For example, in the first stage of the Vanguard you have the kerosene and liquid oxygen.

In the second stage you have the fuming nitric acid and UDMH. There is helium pressurization. There is propane.

So those fuels must all be carried. In addition at the top level we have the latex and the solid fuel.

The trouble is that there is so much elephant and so much equipment to carry for the little rabbit head.

Is research being done to eliminate all that extra equipment, all that extra fuel and likewise to shorten the countdown and also to strengthen the members so that we do not have to depend on all the plumbing and get these leaks?

Are they doing enough on that study?

Dr. YORK. They are doing quite a bit. I am sure more can be done and it will be done.

Mr. FULTON. At Cape Canaveral what struck me was the fuel and the amount of plumbing and the things that went into the program before the satellite orbited. It is a tremendous, tremendous amount.

My question is: First, are you studying it, and, second, how much money do you need really to put a crash program on and get over this hump?

Dr YORK. The answer to the first question is yes, we are studying it. It is being studied not only for the space program. That sort of thing you described is virtually on a crash basis because correcting

or improving all the things you mentioned are intrinsic parts of the entire missiles program, not just the space program.

Mr. FULTON. Is it not a fact that the space program so far has been going along on the basis of just getting what hardware you could out of the missile programs? Is that not a fact that the military has robbed Peter to pay Paul; if you want something for space that has no direct application, it must be taken from a program that has a direct military reason? Is that not right?

Dr. YORK. Well, the Vanguard was not done that way, but the Jupiter-C and the follow-on programs that have been authorized will be done, using military hardware.

Now, insofar as we can with the hardware that is in excess of what the military needs, in order to get things moving rapidly, and because of the fact that there are normally long lead times, lead times which neither we nor the public are willing to wait for, this hardware is coming out of what was originally assigned to the military program.

Mr. FULTON. So you need broader authority for space so that the hardware is ordered for space, and it should be done immediately because of the 2 years' lead time.

Dr. YORK. It should be done as quickly as possible; yes, sir.

Mr. FULTON. I have one other question.

I believe, Dr. Merkle, this would be along your line. One pound of uranium would do the equivalent in a powered missile of a thousand tons of coal and a thousand tons of whatever oxidation equipment you have.

Is that not right, Dr. Merkle?

Mr. MERKLE. From the point of view of energy that is approximately right; yes, sir.

Mr. FULTON. Then there is a real urgency to try to catch up with the Russians, Dr. York, on fuels? I am trying to broaden the field.

Dr. YORK. That holds true, of course, not only in the nuclear field, but in the chemical field, too. There are more fuels that are possible to use than are now being worked on.

But there, again, that is something which is now stepping up in connection with the missiles program as well as in connection with the space program.

The nuclear rocket applies primarily just as the space program.

Mr. Chairman, I wonder if I might be excused at this point.

The CHAIRMAN. The doctor is coming back on the 24th. How much longer do you have, Doctor?

Mr. KEATING. I only have one thing I would like to ask him now, if I could. It will not take over a couple of minutes.

Your position with the Advanced Research Project Agency is chief scientist?

Dr. YORK. Yes.

Mr. KEATING. By its very name, this is looking out into the future to see what we can do.

Dr. YORK. Yes, although we are very much concerned with the immediate space program because by the law ARPA is responsible for these programs for up to 1 year from last February, for all of the space programs.

So we are interested in the future, but we also are very much concerned about the immediate present.

Mr. KEATING. Your responsibility is existing and future?

Dr. York. Yes, in the future presumably for the military programs. For the present for all the programs.

Mr. Keating. Can you give us anything further about your future programs within the realms of security?

Dr. York. We right now, of course, are working with NACA on what needs to be done for the future of civil programs. We are working not just on NACA, but with every one. We are working with Dr. von Braun and his group, people from there and elswhere, trying to determine what a reasonable program for the future is, and we are trying to find out what are the immediate steps that should be taken to get that going.

Of course, as you know, we did authorize the 3 lunar probes for the Air Force and 4 vehicles for ABMA including 2 lunar probes.

There are such things coming along. In our plan there are such things as million pound engines, communication satellites, meteorological satellites, navigational aid satellites, and so forth.

The military programs, of course, are largely classified as to their nature, but they are quite expansive.

Mr. Brooks. I want to ask you this: Is there any particular law that is preventing you from moving ahead or do you have full power now to go ahead with your present researches?

Dr. York. ARPA was just established. It takes a certain amount of time to get people together and get going.

We are still trying to do that. We are moving as fast as we can on that sort of thing.

Also, in 1958, the ARPA budget was only $10 million Next year we expect to have enough so that we can get some vigorous programs going.

Mr. Ford. Dr. York, as I recall, the action which set up ARPA gave you $10 million, plus the right to handle the financing of certain funds from the three services.

These programs that had previously been financed in the area under your jurisdiction—you in turn, and your office, could handle?

Dr. York. We are picking them up as we can. For example, we will have responsibility in ARPA for the remainder of the Vanguard program.

Mr. Ford. Any limitation on funds, I believe, could be handled by transfers out of certain military accounts into the emergency fund and then transferred to ARPA?

Dr. York. We are looking into that; yes.

Mr. Ford. I think that is possible under the law and I believe there are funds in certain accounts which could be used for this period up to the end of fiscal 1958.

Mr. Fulton. But that robs the other funds in order to make these programs.

Dr. York. That is right

The Chairman. Thank you, Doctor

I can see we have only hit the surface with you. I know you will come prepared to answer some more penetrating questions on your next appearance.

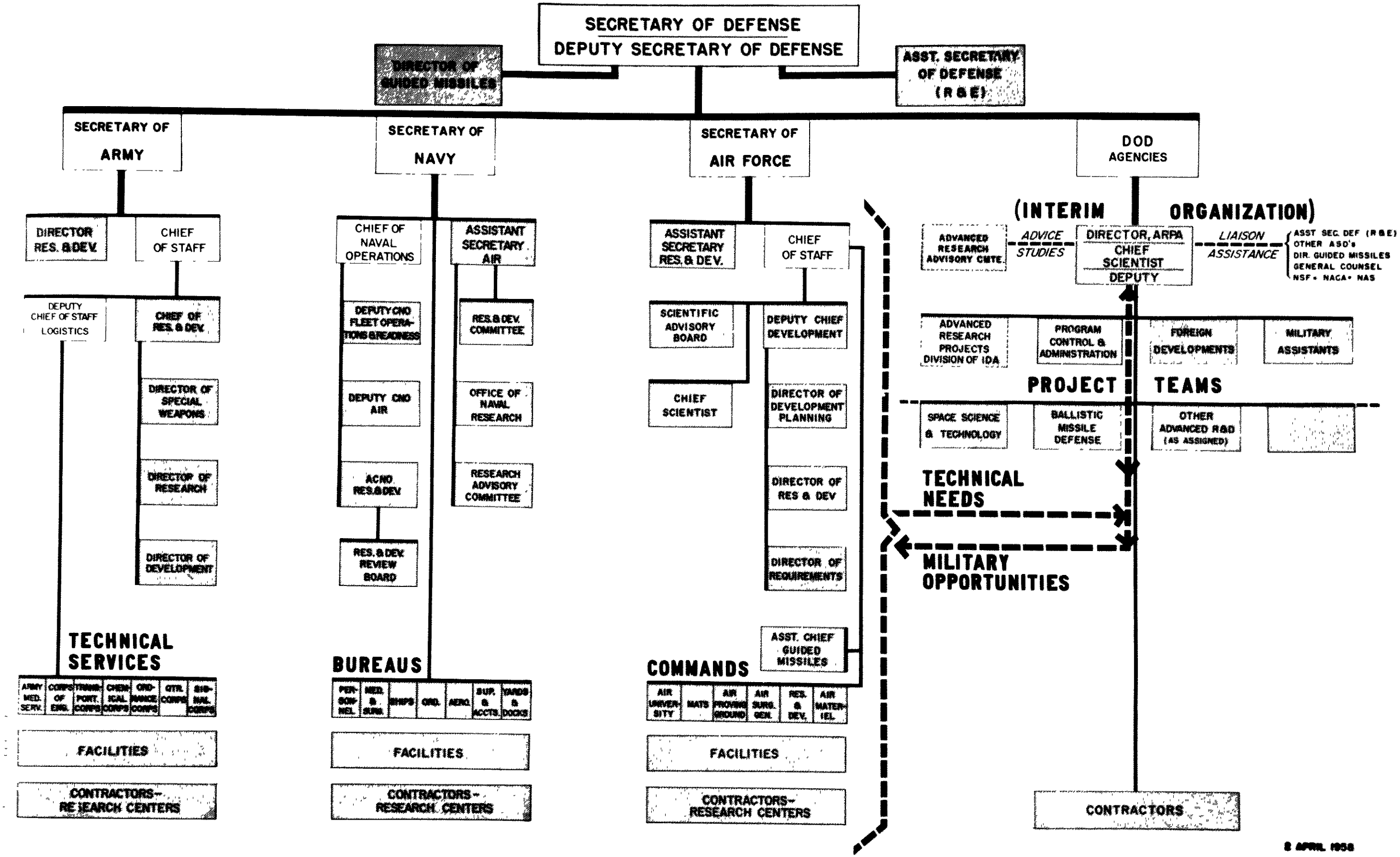
There are a lot of questions we would like to ask and get information on. Thank you, Doctor.

Dr. York. Thank you, Mr. Chairman.

(The Defense Department Research Organization Chart faces this page.)

DEPARTMENT OF DEFENSE

RESEARCH AND DEVELOPMENT ACTIVITIES



The CHAIRMAN. Are there any questions desired to be asked by the committee of Dr. von Braun now?

Mr. SISK. Mr. Chairman, I had a line of questions that I would like to pursue. Do you want me to proceed at this time?

The CHAIRMAN. You may go ahead.

STATEMENT OF DR. WERNHER von BRAUN, DIRECTOR, DEVELOPMENT OPERATIONS DIVISION, ARMY BALLISTIC MISSILES AGENCY, HUNTSVILLE, ALA.—Resumed

Mr. SISK. Dr. von Braun, I would like to refer to a little discussion we had with Dr. York. Do you agree with Dr. York that we are ahead of Russia in basic research or in general research and in what would amount to knowledge, and that primarily where we fail is in the application and actually putting into being the instruments to do the job?

Dr. VON BRAUN. Yes; I find myself in complete agreement with everything that Dr. York said here.

In particular I fully share his view that our general status of research in the natural sciences is not yet lagging behind the Russians.

There are certain fields in which the Russians have the lead, but this is solely the result of emphasis and priorities and effort that they have put behind certain projects, particularly in the missile field.

I do believe, however, that the Russian strides in the field of general and scientific education during the postwar years are so impressive that we should take a long, hard look at our own basic research efforts, to make sure that we are not falling behind in that field also.

The Russian research effort has developed a tremendous momentum, and unless we watch out there is a definite danger of our falling behind in research also.

Mr. SISK. It is your opinion that even though now and for the last few years we have been ahead in this field, unless we accentuate our own program of education, scientific development, that we can fall behind very shortly?

Dr. VON BRAUN. I would say we have been living off our capital in recent years. We are still in the fortunate position of at least not lagging behind them in the research field in general, but I think their momentum is so great that their rate of progress in this field is already exceeding ours.

Unless we put more money and effort into basic research also, we may soon fall behind in that field.

Mr. SISK. Your research work, as I understand from General Medaris, a great deal of it, was done in this country between the time you came over in 1945 right on up until you actually fired the Redstone in 1953; is that right?

Dr. VON BRAUN. Sir, I think what General Medaris meant was that between 1945 and 1951—that is from right after the war, when our German group was brought over to this country, till 1951, when we were handed the high priority Redstone project—we occupied ourselves with general missile research and with the development of certain components and techniques, which advanced the art of rocketry in general, rather than spending our time on immediate weapons projects.

I think he did not mean that all this work was absolutely vital and necessary to start a missile program in this country.

I think what he meant to say was that during those 6 years we were not sitting on our hands; we were doing something worthwhile. But there can be no doubt that we could have done more.

Mr. SISK. I agree with you. The point I was trying to bring out was that apparently the fact that you and your team and apparently others, were doing actual research work is one of the reasons why today we are still not behind. Therefore, it was important to the development of a satellite program as well as, of course, the IRBM and the ICBM with its military applications.

Dr. VON BRAUN. Yes, sir; I think the work performed at that time was quite essential. But with more money and more support more could have been done by the same experienced missile personnel.

Mr. SISK. That is certainly correct.

Of course, the thing was at that time, you were not aware you were falling behind, until at least 1955, even in the application as far as machinery and the hardware is concerned.

Now, I would like to ask you: At Redstone you operate as an arsenal. You more or less do your own development and research work and so on; is that not correct?

Dr. VON BRAUN. Yes, sir. We have an integrated facility at ABMA in the sense that we have our own design office, our own shops, our own guidance and control laboratories, our own static test stands, all operated on the Government payroll.

In addition to our in-house operations we work with a great number of contractors and our accounting shows that well over one-half of the money that goes to ABMA is actually spent in industry.

Mr. SISK. In the development of Thor, for example, and some of the other vehicles, which are to be used, is the service itself or the Air Force or the Navy actually operating on the same basis; is it all being contracted out?

I am trying to get a comparison as to which way will be preferable. Is there a drawback, for example, to the Air Force's position in times past where there is no research, or no work on their own, but they contract it all out?

I am trying to get a comparison between what you have done in Redstone with what has been done in other places.

Dr. VON BRAUN. The Air Force does not have arsenals; it has always contracted all of its development and procurement jobs solely in industry.

The reason behind this is very simple. The aircraft industry has civilian customers in addition to their main customer, the Air Force. They sell their airplanes to commercial airlines, both United States and foreign, and also to private customers.

In most fields of Army weaponry, however, there is no civilian market. There is no civilian customer for an item like a machinegun or a tank. So the Army, historically, had to build up Government-operated arsenals to have these kinds of things developed.

With the Navy the situation is very much the same. The Navy has quite a number of Navy-operated shipyards, to which special tasks are assigned that a normal private shipyard is not prepared to handle.

Now, due to the ever-increasing complexity of weapons systems, things have become a little bit involved for the Air Force, too, and

I think their missile program is a pretty good example of what I am talking about.

In complicated new weapons projects you can no longer simply go out and contract all your components without having a group of scientists and engineers sitting in the driver's seat and coordinating the overall effort, coordinating the weapons system as a whole.

In order to do that, the Air Force has availed itself for its ballistic missile program of the services of a private corporation which does essentially the same project coordinating job which is part of what we are doing at ABMA, only they do it under contract.

The Air Force contract I am referring to has been awarded to the Ramo-Wooldridge Corp. It specifically excludes Ramo-Wooldridge from building any missile hardware because their main job is to coordinate the overall program and to advise the Air Force, as to who is the most promising bidder for a certain component.

So the Air Force has found it necessary, too, to create a kind of in-house systems coordination capability in order to handle these vary complicated weapons systems. There is very little difference left between this system and the Army's arsenal concept.

Mr. SISK. Doctor, I appreciate your statement very much because that is the point I was trying to reach. We are all interested in seeing private industry do as much of this job as possible, yet in the interest of time and in the interest of moving ahead in a satellite program and in the exploration phase, I gather from what you say that it is necessary to have a nuclear scientist or have a certain arsenal-type operation rather than simply contracting out or simply asking a particular corporation to work out and build up a certain instrument.

There is one further question I would like to ask you. In view of the fact there has been more than one instance where the Army was stopped in its program, at least in an attempt to put a satellite into orbit, for example, Orbiter, the Army was working on in 1955, do you feel there was any bearing whatsoever on that due to the fact you were operating as an arsenal rather than contracting your work all out?

Dr. VON BRAUN. I do not believe that in the particular case of our satellite situation we have been affected by such considerations. The Department of Defense in 1955 appointed a committee to evaluate three independent proposals on how to build a satellite. These proposals had been submitted by the Air Force, the Army, and the Navy. The Navy proposal was finally picked, mainly because it promised to carry the largest payload with the smallest and lightest rocket vehicle.

The Navy proposal required, of course, the development of a brand new three-stage rocket, now known as the Vanguard missile, whereas our proposal was based essentially on a combination of existing and available rocketry.

Mr. SISK. Did you agree with that decision, Dr. von Braun?

Dr. VON BRAUN. I think the decision was a good one from the point of view of getting an advanced satellite rocket, namely, the Vanguard, started. It was a very risky decision in 1955 because it meant that something had to be done within 2 years that had never been done before in 2 years. The fact that a few weeks ago the Vanguard missile has successfully placed a payload in orbit indicates that the Vanguard has been developed by a very capable team.

I frankly admit they exceeded my expectations. I never thought they would make it on time.

Mr. SISK. Hindsight is always better than foresight, but you had a vehicle at that time which had been rather well tested and on which there had been a lot of research.

Frankly, I and many other people have been a little bit concerned as to why a wholly new vehicle was selected at this time in preference to a tested and tried vehicle. There is no criticism of people who made the decision.

Dr. VON BRAUN. I believe if they had told us back in 1955 that we would have to fire a satellite only in January 1958, we may have come up with a more sophisticated proposal ourselves.

As I told you, we could have fired a Jupiter-C in orbit as early as fall 1956.

Mr. SISK. That is my understanding. You feel you could have put a satellite in orbit in 1956?

Dr. VON BRAUN. We successfully fired this very same Jupiter-C missile in September 1956 and I think with this firing we proved that it could have been fired into an orbit as well.

Mr. SISK. Is it a fact that at the time there was so much pressure to be certain you did not put that instrument in orbit that people came down to see to it that certain parts of it were not activated; is that correct?

Dr. VON BRAUN. Yes, sir.

Mr. SISK. That is all, Mr. Chairman.

The CHAIRMAN. Doctor, in the bill it says:

(2) Subject to the civil-service laws, to select, appoint, employ, and, subject to such regulations as the President may prescribe and without regard to the Classification Act of 1949, as amended (5 U. S. C. 1072, et seq.), and the Federal Employees Pay Act of 1945, as amended (5 U. S. C. 901, et seq), fix and adjust as nearly as consistent with the public interest and on the basis of equal pay for equal work at rates which are reasonably comparable with prevailing rates paid by non-Federal employers for similar work, compensation of such officers and employees as may be necessary to carry out the provisions of this act;

Do you have that same provision of law in relation to those associated with you?

Dr. VON BRAUN. Yes, sir; I have it in front of me.

The CHAIRMAN. In other words, those in the field of science may be employed without regard to the Classification Act of 1949?

The reason I ask is to find out whether the provision of this bill if enacted into law would in that respect cause repercussions in other directions where professional men could not be paid under similar conditions.

In other words, this is a relative matter. I want to explore it.

Dr. VON BRAUN. Sir, I believe one of the most serious difficulties in handling large weapons systems development contracts or other research and development projects for the Government is this:

Here is, shall we say, a million dollars that we want to spend wisely on some advanced research or development project—no matter whether it is in the field of rocketry or space or radar or anything.

How can you spend it wisely? You need people with judgment who can decide what the Government ought to have. For the Government, in order to avail itself of the services of such people, it is a good idea to retain about 10 percent of that million dollars, say

$100,000, for the purpose of providing the talent and the capability of determining how to spend the remainder; namely, the $900,000.

In recent years it has become increasingly difficult to determine what is a sound and promising technical proposal. In order to evaluate the many proposals that the Government receives from industry, and in order to decide which is best from the taxpayers' point of view and to whom the contract should go, you need talent and experience on the Government payroll, too.

The Government has been chronically suffering from lack of real topnotch talent on the Government payroll, because once a man is so experienced that he can evaluate a series of weapons systems proposals, he can make many times as much money working in industry and preparing proposals for the Government rather than by sitting there behind a Government desk evaluating such bids.

I think this is a very fundamental and serious problem for the Government. If you want to cut waste, there simply must be more talent, more experienced talent on the Government payroll to decide where the tax dollar should go.

The CHAIRMAN. I was not questioning this. I wanted to inquire whether you had the same authority.

Dr. VON BRAUN. To hire people outside the civil-service pay structure? No, sir; we have not.

The CHAIRMAN. Could you go out and employ a scientist without regard to the Classification Act?

Dr. VON BRAUN. No, all our personnel are on the civil-service payroll.

The CHAIRMAN. What effect will it have upon those associated with you to know that this agency is paying more for scientists than you can pay?

Dr. VON BRAUN. Industry is also paying more than we can offer. We are used to the temptation.

The CHAIRMAN. I can see where men are dedicated. I realize that. But I can see where a man who is a scientist associated with you and, say, getting $15,000 a year—where that is the limit—we just pick that out of the air—and where another scientist working for this new agency is getting $20,000 a year, he might say, why this differential?

Dr. VON BRAUN. Well, sir, my personal opinion is that this problem of salaries for scientific personnel which has come into focus here in connection with the new space agency is a very widespread problem throughout the Government services.

The CHAIRMAN. I meant to ask Dr. York, but I will ask him later about what the situation is in his agency in relation to those with specialized qualifications.

Now, are you familiar with the letter sent by Dr. Frederick L. Hovde, Chairman of the Scientific Advisory Panel, to Secretary Brucker on October 30, 1957?

Dr. VON BRAUN. I am not certain, sir, that I know this particular document.

The CHAIRMAN. That is public. There is nothing classified about that because I ascertained that. This letter was the unanimous report of the panel, consisting of between 55 and 60 outstanding members. It says they went into the whole situation as they saw it.

Among other things, they said

The problem before the Nation is not simply one of money, facilities, nor even men—these we have in substantial amounts and that which we don't have can be provided.

Whatever the failures may be, they are primarily those of management—in which we have a share—which result in delays in decision-making and confusion in the direction of our technological forces.

Have you any observation to make on that?

Dr. VON BRAUN. I think that statement makes a lot of sense.

The CHAIRMAN (reading):

Despite rapidly developing pressures for immediate reorganization, a thorough diagnosis of our management ills must be made before remedies are prescribed.

We believe the Army's position in such a reassessment must be clear, unequivocal, and stated in terms that both our leaders and our citizens can understand and support.

The objectives can be stated—there are major deficiencies in our research and development management system which must be eliminated without destroying the entire structure.

The Army Scientific Advisory Panel recommends unanimously that the Department of the Army support proposals and actions which will produce the following results with respect to the management of science and technology for national defense:

I. (a) A redefinition and clarification of individual roles and missions of the services in areas where this is possible in the light of present and predictable conditions

(b) Freedom and authority for each service to carry out research and development effort necessary to discharge its obligations as delegated in its individual mission.

(c) A clear-cut recognition and definition of national missions which require the support of two or more services—continental air defense is an example.

(d) An effective mechanism for directing research and development effort to support these national missions.

II. Recognition and understanding at the highest Government levels of the real impact, significance, and meaning of science and technology to national defense, with continual review.

III. Improvement, through reexamination, definition, and organization, of the management procedure of decision making throughout the whole structure of national defense:

(a) To avoid present confusions concerning authority and responsibility.

(b) To support projects at optimum rates and reduce time lag between the conception and use of new weapons.

(c) To permit decisions early in the development stage, thereby stopping expenditure of money, man, and facilities when further investments will result in marginal improvements or obsolete weapons

(d) To eliminate that duplication of effort which leads to inefficient use of time, money, and manpower, retaining the advantages that accrue from multiple approach to high priority development programs in their early stages of evolution.

IV. Technological superiority cannot be secured nor long maintained unless the source from which all our future scientific strength comes is nourished and encouraged—namely, national progress in basic research and the advanced education of those of our talented young people who can become the scientists and engineers of the future.

Neither the Army nor the other services will be able to discharge their future responsibilities for national defense if means are not found, by the Department of Defense or other agencies, to support a more substantial effort in fundamental research and in training of the qualified students.

The Army Scientific Advisory Panel believes these objectives are sound and attainable, and all members of the panel stand ready to assist you in achieving them.

Had you seen that before?

Dr. VON BRAUN. I had not seen it before, but I am familiar with the general tenor of this paper, because we have very much the same complaints. For example, we have been complaining for years that

we have too little general research money at our disposal, compared with the very sizable amounts of money we get for weapons systems development. There has never been enough noney to just advance the art as such and to make progress in fundamentals.

The CHAIRMAN. The important thing is, whatever the failures may be, they are primarily those of management. That means top-level decision and authority to carry it out.

Has your experience been along that line?

Dr. VON BRAUN. I can only say that we don't get enough research money. Whose fault it is I don't know, but we have been asking for this kind of money that we can use for supporting research—without any further strings attached—we have been asking for it for years. But for some mysterious reasons this kind of money is very hard to come by, although the figures involved are very small compared with those involved in the development of a well-specified new weapons system.

The CHAIRMAN. Without objection, I will put this letter in the record.

(Letter referred to follows:)

DEPARTMENT OF THE ARMY,
RESEARCH AND DEVELOPMENT,
ARMY SCIENTIFIC ADVISORY PANEL,
Washington, D. C., October 30, 1957.

Hon. WILBER M. BRUCKER,
Secretary of the Army, Washington, D. C.

MY DEAR MR. SECRETARY: At this time, when military implications of science are so much in the public mind, you may have special opportunity to express the Army's views about reassessment of our national defense research and development program. As an aid in formulating those views, your Scientific Advisory Panel offers the following discussion.

The application of science to warfare has reached the stage where the principal guaranty of national security in the years ahead is the maintenance of scientific and technological superiority.

Revision of the management and operating structure of our research and development effort should be accomplished through careful analytical assessment on the part of our leaders and representatives with the objective of eliminating that which experience has taught us is inefficient, slow, and wasteful in our present system. Hysterical action or overhasty reorganization may result in confusion and real injury to that which is already good and productive in our existing defense system.

The problem before the Nation is not simply one of money, facilities, nor even men—these we have in substantial amounts and that which we don't have can be provided.

Whatever the failures may be, they are primarily those of management—in which we have a share—which result in delays in decisionmaking and confusion in the direction of our technological forces Despite rapidly developing pressures for immediate reorganization, a thorough diagnosis of our management ills must be made before remedies are prescribed.

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The Army scientific advisory panel believes these objectives are sound and attainable, and all members of the panel stand ready to assist you in achieving them.

Yours respectfully,

FREDERICK L. HOVDE,
Chairman, Army Scientific Advisory Panel.

Mr. FULTON. Actually, on that particular point of the availability of the scientific resources of this country, we have talent available now in the guided missile or satellite and research fields which is not being used because the people are unemployed, or the program, such as the Navaho program of North American, has been canceled by the Government.

What percentage would you say of our crew of scientific talent in this field in the United States is at present unused?

Dr. VON BRAUN. I would say, in the guided missile field, at least 30 percent of our topnotch talent is not effectively used.

Mr. FULTON. Then if you take into consideration those who are running around as scientific salesmen in cars, trying to sell scientific programs, which is certainly a misuse of their talents, how many more percent would you say is being misused?

Dr. VON BRAUN. I would say these two things are very closely interwoven. The pattern usually is this: It is unavoidable that there is a certain amount of continuous reorientation in military programs. The Navaho is a pretty good example.

When the Navaho program (which is a supersonic, ram jet, long-range missile) was originally started in about 1950, it was a fine and progressive missile program. But since it took too long to develop, by today's standard, the Navaho would be obsolete. The antiaircraft missiles have caught up with this cruising type of long-range missile

and to continue its still uncompleted development would only lead to an obsolete weapon.

Mr. FULTON. Actually, are we not behind Russia in the utilization of our scientific manpower? They do not waste it like we do, do they?

Dr. VON BRAUN. What I am driving at is that there are unavoidable reorientations and outright cancellations in the missile development business. Now, every time you have such a cancellation you throw a sizeable engineering force out of work. When the Navaho was canceled, there were several thousand experienced missile people who suddenly had nothing to do. Of course, the employer will always try to keep them on the company payroll, at least the top talent and the most experienced scientists and engineers and skilled technicians, in order to be able to take on another project.

Then, in order to get that other project, it is standard operating procedure that large teams of brilliant scientists and engineers are sent out to hit the road and go to Washington and try to get a new missile project from the Pentagon.

Mr. FULTON. That is a waste of manpower?

Dr. VON BRAUN. Yes, sir; a tremendous waste of our best talent in the missile field.

Mr. BROOKS. I would like to ask you this, Doctor.

What in your experience in reference to the results obtained in doing the work yourself, and using the method of farming out, of contracting out a project?

Do you find it preferable, do you get the same results or better results by doing the work actually at Redstone or by contracting out a project; for instance, the development of an engine?

Dr. VON BRAUN. We do things inhouse, whenever there is a need for a quick improvised solution and where results are needed fast, where we cannot wait to evaluate lots of contractors' proposals and so forth. But our philosophy is to do inhouse as little as possible and to contract out what we can just as well get from a contractor. In our experience this combined arsenal-industry method is the quickest way of getting results.

Mr. BROOKS. You find that either one is effective if you do it with discretion?

Dr. VON BRAUN. Yes, sir.

Mr. BROOKS. Is that the point?

Dr. VON BRAUN. We could not possibly handle everything in-house, but I think if we depended exclusively on contractors and proposals we get from the outside, our progress would be much slower.

Mr. KEATING. On that point, may I inquire?

At the present time, do you feel that the division of responsibility between private contractors and your own, what you call in-house, is satisfactory; or are there changes which you feel should be made?

Dr. VON BRAUN. I have the impression that our contractors are quite satisfied with the arrangement.

Mr. KEATING. Are you satisfied?

Dr. VON BRAUN. We are very satisfied. If you would call these contractors in and ask them to testify on how they feel about it——

Mr. KEATING. I was thinking of it from the point of view of the Government, whether you, as a responsible person in charge of a certain division of this work, were properly satisfied about that present

division or responsibility or whether you thought some changes should be made?

Dr. VON BRAUN. No, sir; we are satisfied and we have every reason to believe that our contractors are also satisfied.

Mr. KEATING. Now let me ask you a question.

I have been concerned, as has the chairman apparently, by the provisions to which he referred about employing top personnel in this space agency. If we were to enact legislation allowing the space agency to pay any amount they thought best to professional people and you in your development were not given similar authority, would that not prejudice you in keeping your personnel or getting new personnel in your area of activity?

Dr. VON BRAUN. As I said before, we are used to being exposed to this salary differential with the industry already. By putting the space agency outside of the civil service pay structure you would just add one more outside agency to the list of industrial corporations that are paying higher salaries than the Army Ballistic Missile Agency. As bad and difficult as our position is in this salary area, I feel this one additional hurdle would not upset the applecart either.

Mr. KEATING. Do you not think there is a distinction between private industry having that capability—and there is no way that we in Government can completely meet that problem—and giving that authority to another governmental agency?

In other words, there are scientists who get something other than what they earn—I am sure you are a prime example of that—who get a thrill out of working for the Government and are not attracted oftentimes by a very much larger offer from industry. But if this existed, would this not be a more serious threat to the people working in your area than the industry threat? I do not know.

Dr. VON BRAUN. I think in the long run the Government is faced with this salary problem for scientific personnel in other areas, also.

Mr. KEATING. In your area, also, and perhaps others?

Dr. VON BRAUN. I mean it has come into focus in this particular case, but that problem exists in many other areas.

Mr. KEATING. I share that view.

The CHAIRMAN. What salary do you get, Doctor, in your responsible position?

Dr. VON BRAUN. Nineteen thousand dollars.

The CHAIRMAN. This bill provides $22,500 for the new Director. How do you feel about that? Do you not feel you are entitled to $22,500?

Dr. VON BRAUN. I think the new Director should take the job and keep it.

The CHAIRMAN. Doctor, in the contracts that Redstone makes under your authority for the Department of the Army with any private companies or laboratories—are they private companies, too? Do you make contracts with corporations?

Dr. VON BRAUN. Yes, sir.

The CHAIRMAN. Supposing they make any discoveries, does the Government get the benefit of those discoveries?

Dr. VON BRAUN. Yes, sir; the question of patent rights is tied up in the contract.

The CHAIRMAN. If you have occasion to contract with another company, you can let that other company know of these discoveries that were made?

Dr. von Braun. Yes, sir. Anything that is being patented under a Government contract is Government property.

Mr. Keating. Is the thrust of one 300,000-pound engine the same as the thrust of three 100,000-pound engines?

Dr. von Braun. Yes, sir.

Mr. Keating. You made the point that it would be preferable to have one 1-million-pound thrust rather than several that made up 1 million. Would it be too technical for us if you explained why that is?

Dr. von Braun. Sir, it is possible, of course, to get a million pounds thrust out of clusters of the most powerful engines we have today. I think the thrust of these is well known. It is 150,000 pounds thrust. So you would need about seven of them to get a million pounds, approximately. It can be done this way, but it is not a very good way of doing it because the cluster of seven engines contains so many components that you lose reliability.

Mr. Keating. In other words, if you have one engine, you have fewer components to go wrong?

Dr. von Braun. Yes, sir.

Mr. Keating. That is the main reason why it is better to do it with one engine?

Dr. von Braun. Also, clustering is very heavy.

Mr. Keating. One final question.

We have all indulged in a good deal of speculation. Suppose in the late forties, or right after the war, we had moved, as you and Dr. York, as you look back on it, would have liked to see us move at that time, when would we have had a satellite in orbit in your judgment?

Dr. von Braun. I think had a satellite crash program been initiated right after the war—I realize it could not have been done because nobody was then interested in this kind of a thing—but from the purely technical angle I think we could have fired a satellite in 1950, 1951, or 1952, something like that.

Mr. Ford. As I recall, Dr. von Braun, you indicated you got the go-ahead on the Redstone program in the spring of 1951?

Dr. von Braun. Yes, sir.

Mr. Ford. From a technical point of view, could you have proceeded at an earlier date?

Dr. von Braun. Yes, sir; in 1946.

Mr. Ford. As I also recall your testimony of this morning, you indicated the breakthrough in the Redstone program in 1954 was the element which gave us the ability to move into the satellite field. If that is so, if we had started earlier than 1951 in the Redstone program, we could have possible orbited a satellite at an earlier date; is that right?

Dr. von Braun. Yes, sir. You can look at it this way: The Redstone program was initiated in 1951. The satellite proposal using the Redstone was made in 1954, and a satellite capability with the Redstone definitely existed in late 1956. Now, had we moved this entire program up 5 years and begun the Redstone development in 1946 instead of 1951, you would have had the satellite capability in 1951.

Mr. Ford. In other words, the scientific knowledge was there, you just needed that much lead time whenever you got the go-ahead signal?

Dr. VON BRAUN. Yes, sir; the most effective way to possess a missile 2 years earlier is to begin work on it 2 years earlier; this simple truth is very often overlooked. We usually wait and wait and then all of a sudden initiate a crash program.

Dr. FORD. I gather in the discussion of the Navaho cancellation, we should have done 1 of 2 things: We either should have pushed the program more rapidly at the time of its inception, or we should have canceled it at an earlier date, because in the meantime the subsequent developments have taken place which in the minds of many made that particular project an obsolete weapon.

How do you know from a technical point of view, and I am sure you have had this in various programs yourself, when to go through this process of cancellation or when to push it more rapidly?

Mr. VON BRAUN. Sir, I have never criticized the cancellation of the Navaho as such, nor the timing of the cancellation. I think it is unavoidable in military developments of this kind that you have to proceed along the lines that appear most promising at the moment, and review such projects at regular intervals to see how they stack up with the rest of the world; in other words, to find out if this is a desirable weapon or has it become obsolete in the meantime. As a result, a certain number of reorientations and cancellations will always be necessary.

I think what happened in the case of the Navaho was entirely natural, and nobody should be criticized for the cancellation as such. I think the question that deserves more attention is what to do with a well-proven research and development group such as this Navaho team, in the wake of a cancellation. Nobody seems to feel responsible for keeping such a team intact. There is a widespread feeling that the Government owes nobody a living and so industry must see for itself that they get the new contracts. This sounds very brave and noble, but it is an utterly wasteful procedure because it is not the businessmen and the salesmen but the scientists themselves, who now have to go out on the road and see to it that the company gets new missile business.

I believe in this area of what you might call program and team stability, we can really learn something from Soviet Russia. In Russia they do not have the problem of competitive bidding, and the concern on the part of the Government employees that they may be accused of favoritism if they award a contract to a plant which, through a procedure which is as formal as it is miraculous, has not been determined to be the most suitable for the job at hand. The plain fact that in a Communist economy all factories are run by the Government direct, makes the procedure of contract award extremely simple: Whenever a development team is available to take on a new job, it just gets one.

I think we have enough missile development teams in this country who have demonstrated repeatedly that they can perform if called upon regardless of whether the missile is a ramjet or a ballistic rocket. If we would just go to these teams with our new missile or space projects and see to it that they are all utilized on a reasonably balanced and constant load level, we would be much better off. At the moment, we turn missile projects on and off like a faucet and do not care what havoc this creates within the carefully organized development teams. To build up a good team takes years, to wreck it takes

a few moments. And yet, these experienced development teams are our greatest single national asset in the race for leadership in missiles and space exploration.

Mr. McDonough. This Navaho project was a North American project?

Dr. von Braun. Yes, sir.

Mr. McDonough. At the time it was discontinued, it created quite a shock in the community out there because of the number of people who were affected by it. We made an effort, the California congressional delegation and others interested, to see to it that those teams were not broken up, if possible. We were conscious of the very thing you are saying here, that the experts would be dispersed and could not be reassembled.

It happened that when these men were notified they would no longer be needed, a number of other firms in the immediate neighborhood took them on. I think many firms took them on to hold them in reserve, not even to put them in immediate employment. Hughes Aircraft, I think, has a large reserve of physicists and mathematicians and scientists.

I do not know what the answer is, but it is very essential that this committee, or the Congress, should give consideration to it in order to create a continuity of thought and development and exchange of data, and to implement some of the basic research that we are studying.

Since you said a moment ago that we could have put a satellite into orbit sooner than we did, were you at all surprised at the time when the Russian satellite was announced?

Dr. von Braun. No, sir; I was not surprised. I was just disappointed.

Mr. McDonough. Following the announcement and the so-called propaganda effect it had upon the United States and the rest of the world, we then attempted to put a couple of satellites in orbit. You say we were prepared in 1956, but we failed in 2 or 3 efforts after that until we put a couple in orbit, did we not?

So we were not quite so prepared as we thought. You say we could have put one into orbit in 1956, and following the Russian satellite, in our attempt immediately after that, we failed a couple of times. I do not mean the Army.

Dr. von Braun. I was solely referring to our satellite capability based on the Redstone missile.

Mr. McDonough. You could have done that earlier with the Redstone?

Dr. von Braun. Yes. The early failures in the Vanguard program were the unavoidable teething troubles of a brandnew missile. These should have been hardly surprising. All our missiles were plagued with such difficulties and setbacks in their early testing phase. This kind of thing is almost accepted as normal operating procedure. In the case of Vanguard these early failures merely received more publicity, that was all.

Mr. McDonough. Are you familiar with the X-15 project?

Dr. von Braun. Yes, sir.

Mr. McDonough. That is a rocket plane, is it not?

Dr. von Braun. Yes, sir.

Mr. McDonough. Man-operated?

Dr. von Braun. Yes, sir.

Mr. McDONOUGH. It is estimated to travel how far into space, 100 miles?

Dr. von BRAUN. Yes, sir.

Mr. McDONOUGH. More than 100 miles?

Dr. von BRAUN. No. I think it can reach nearly a hundred miles in a so-called a ballistic flight pattern. It is designed to be dropped from a B-36, then travels like a ballistic missile, through a ballistic trajectory, but it levels off into a glide after reentry into the atmosphere.

Mr. McDONOUGH. Since that will be the first attempt to send a man to that height, do you think that he can return to earth safely?

Dr. VON BRAUN. Yes, sir. I doubt, however, that this must necessarily be the first attempt to send a man to that height I am convinced we could get a man up there substantially sooner than with the X-15 if we just used an existing and well-proven rocket.

Mr. McDONOUGH. You mean you could send a man in a rocket faster than the X-15 right now?

Dr. VON BRAUN. Yes, sir. We have worked out a detailed proposal to send a man with a Redstone missile 150 miles up. I am convinced, in fact I know, that this could be done sooner than with the X-15.

Mr. McDONOUGH. And return safely?

Dr. VON BRAUN. Yes, sir.

Mr. McDONOUGH. How do you decelerate your speed through the atomosphere coming back?

Dr. VON BRAUN. We propose to separate the nose section with the man from the rest of the missile prior to reentry in the atmosphere. The man himself will be in a pressurized capsule which is inserted into the nose section. The latter is equipped with controllable airbrakes which retard the fall as it gets back into the atmosphere. I must add, however, that this program has not received official approval yet. I do not know why. ARPA knows about it, but has not yet decided on it. There is a question of money involved, I believe.

Mr. McDONOUGH. Can this committee find out why for you?

Dr. VON BRAUN. I would appreciate it very much, sir.

Mr. McDONOUGH. You mean on the rocket-propelled, man-carrying capsule?

Dr. VON BRAUN. Yes, sir.

Mr. McDONOUGH. You want to know why it cannot be done before the X-15?

Dr. VON BRAUN. I know it can be done sooner than the X-15. Our proposal which we recently submitted give all the facts and figures, scheduling estimates and an accurate statement on how much it would cost. It is a relatively cheap program, but to our surprise we have not found much support for the idea yet. Some people have taken the position that it would be nothing but a stunt. But we've been told the same when, back in 1954, we first suggested a minimum satellite with the Redstone missile.

Mr. McDONOUGH. In other words, you want to know why you cannot be authorized to do it?

Dr. VON BRAUN. Yes, sir.

Mr. McDONOUGH. I think it is important to find out.

Dr. VON BRAUN. I am convinced that if we don't tackle this project quickly that this will be one of the next surprises the Russians are going to pull on us—to shoot a man 100 or 200 miles up and get him down again. I am not talking about manned orbital flight. I am

talking about just a manned shot up to that altitude with ensuing recovery.

Mr. McDONOUGH. Now you are speaking about a rocket-propelled capsule in which a man is contained, and the rocket is disposed of, the engine is disposed of. He does not come back with that equipment?

Dr. VON BRAUN. Specifically, our equipment is based on the well-proven Redstone missile again. The idea is simple to bring a man to an altitude of 150 miles. We would separate the nose of the missile from the Redstone shortly after power shutoff. The nose is equipped with aerodynamic brakes and some control equipment. There is also a parachute for the last portion of the descent to land him safely and smoothly on the ground.

Mr. McDONOUGH. He will be contained in a capsule like a satellite is sent into orbit?

Dr. VON BRAUN. Yes; and he will be in outer space for over 6 minutes during which he could make many observations.

Mr. McDONOUGH. He can propel himself into space after he is released from the rocket, and return?

Dr. VON BRAUN. Shortly after the Redstone engine goes out, the nose section with the human capsule will be separated from the rocket. Nose section and man will then coast unpowered through the apex of the trajectory 150 miles up, and thereafter descend back into the atmosphere. Finally he will land on the ground where we will retrieve him.

Mr. McDONOUGH. I think, Mr. Chairman, this committee should find out why they have not been authorized to proceed on this development.

The CHAIRMAN. We can consider that in executive session. Will you bring it up?

Mr. McDONOUGH. Yes.

Do you have any volunteers for this, Doctor?

Dr. VON BRAUN. Yes, sir.

Mr. McDONOUGH. You have?

Dr. VON BRAUN. Yes, sir.

Mr. KEATING. I was told down there that a dozen young fellows are all ready to move.

Mr. FULTON. How about some of us on the committee? I am willing to try it.

Mr. McDONOUGH. Lockheed has already assigned the job for taking up the X–15.

Dr. VON BRAUN. The X–15 cannot possibly be ready to reach 100 miles altitude at the time when we could hit 150. It will be substantially later than our schedule.

Mr. McDONOUGH. Something in 1959 or 1960?

Dr. VON BRAUN. Yes, sir.

Mr. McDONOUGH. You could do it quicker than that?

Dr. VON BRAUN. Yes, sir. Quicker than the X–15, and we could also go higher.

The CHAIRMAN. Mr. Feldman, have you any questions?

Mr. FELDMAN. Yes, sir.

The CHAIRMAN. I want to say that you gentlemen have been very cooperative, and we appreciate it. It has been most helpful. We are pioneering ourselves. I am frank in stating that I am starting practically from a position of ignorance, but trying to apply my common

sense as a legislator as to what is best to do in the interest of our country. You are helping us invaluably.

Mr. FELDMAN. Dr. von Braun, this is corollary to the question asked by Congressman O'Brien of New York. We talked about spending a lot of money for these projects. But we are also concerned with this question of payoff, the quid pro quo.

For example, over $14 billion has been spent in connection with the atomic energy project of one kind or another. I am advised by an authoritative source that the capitalized payoff from isotopes alone in the case of atomic energy has been greater than the $14 billion we have spent on these projects.

Do you feel that the peaceful-use payoff, like the question of weather control or weather forecasting, or, the question of communications and other developments we do not know of at present, will have a corresponding value?

In other words, will they, too, pay off in terms of dollars and cents just as the isotope has paid off in the case of atomic energy?

Dr. VON BRAUN. Yes, sir; I am convinced that certain applications of space technology will become very valuable payoffs. Particularly, the communications satellite is promising in this regard, also the weather forecasting satellite. Now, the communications satellite can be a useful commercial tool, particularly in two areas. One is as a radio link for global television. Imagine several satellites equipped with relay transmitters, and working in compound. One satellite at the time would always be in direct line of sight contact with an American TV transmitter station, while the others would pick up these relayed signals and pass them down from whatever country they happen to be over.

With six relatively small, unmanned satellites assigned to this mission, you can provide a global television hookup.

In the field of radio communications, it is conceivable to build satellites equipped with radio receivers and multichannel type recorders to which you can radio telegrams or letters while the satellite is speeding over one city. Upon a signal from the ground from another city the satellite is instructed to play back whatever messages were addressed to that city; as the tapes are played back they are cleared to take on new messages for the next major city to be flown over by the satellite. In a modest way, we are using this same technique already on Explorer 3, which has a tape recorder and a playback feature and a coded command receiver, so that on instruction from the ground the tape can be played back. This same technique, in a somewhat more elaborate fashion, lends itself beautifully to general communications services such as I just described.

If you combine the modern coding techniques that are used in electronic digital computers with these multichannel tape recorders, you get a tremendous mail handling volume. These modern electronic coding methods permit the printing of the text of a whole book within a few seconds. It has been computed that with 6 communications satellites of this kind one could handle the entire mail volume of the whole earth.

When you further consider that such a satellite message would never take longer than 1 hour from sender to receiver, it would appear reasonable to charge at least 1 penny a word for this global mail service. This would not only pay for the service as such, but in

addition could provide enough funds for trips to the moon and other ventures into deeper space.

Mr. FELDMAN. It would pay for itself many, many times; is that right?

Mr. FULTON. Actually, you could have a recorder on that basis which would play back information on all the armies, the navies, and air forces of the whole world, and you would know wherever one of them might be on this kind of satellite; is that not right?

Dr. VON BRAUN. Yes. You could actually take over the job of hauling long-distance mail from the post office and make a source of revenue out of it.

Mr. FULTON. For military purposes, you would know where everything is all the time, all the armies, the navies, and the air forces of every country in the world?

Dr. VON BRAUN. This would be the job for a military reconnaissance satellite.

Mr. KEATING. He did not mean that the Postmaster General would take over the military.

Dr. VON BRAUN. I think Mr. Fulton was talking about the television satellite looking down on potential enemy territory and playing the pictures back over friendly territory.

Mr. FULTON. If there were a change from the original photographs, the satellite itself would record where the change was?

Dr. VON BRAUN. Yes, sir.

Mr. FELDMAN. The expenditure, then, would more than pay for itself. Would you go even further and say, for example, that, just as the automobile industry created a great deal of employment and was followed in turn by the radio industry and television industry and the airplane industry—would you say, after the thinking stage was concluded in connection with rocketry or satellites and we had gone into production, that a large segment of our labor would be employed in the projects?

Dr. VON BRAUN. Yes, sir; most certainly.

Mr. FELDMAN. And that instead of unemployment, we might have a shortage of labor?

Dr. VON BRAUN. I firmly believe rocketry and space technology will create a new industry just like the aviation industry and many others. In fact, this process is already in full swing.

Mr. FELDMAN. How long would you estimate it would take to go from the thinking stage into the development and production stage?

Dr. VON BRAUN. There are many space projects ready to go immediately into the hardware development stage. All that is needed is money.

Mr. FELDMAN. That would begin to employ people, is that right, in a useful capacity?

Dr. VON BRAUN. Yes, sir.

Mr. FELDMAN. Addressing ourselves again to the legislation, Doctor, should there be, within the Agency, a military division similar to that of the AEC's Division of Military Application, which is headed by an active member of the Armed Forces and a military liaison committee composed of representatives of the Army, the Navy, and Air Force?

Dr. VON BRAUN. You are referring to the National Aeronautics and Space Agency?

Mr. FELDMAN. I am referring now to the new NASA proposal.

Dr. VON BRAUN. Yes, sir.

Well, I feel the military and the scientific programs are so closely interwoven that it is absolutely necessary that there be a close and continuous cooperation between the armed services and this Agency. I think AEC has set a fine example here, and AFSWP, the military liaison group to AEC has demonstrated how to do it.

Mr. FELDMAN. You would agree that setup is a useful one and has worked very well in the case of the liaison between the Armed Forces, the various brances of the Armed Forces, and the AEC?

Dr. VON BRAUN. My own personal experience in this area was very favorable. We found very smooth cooperation in everything we ever did jointly with AEC.

Mr. FELDMAN. In connection with the area of aeronautics and astronautics, would you think there should be a separation of the two functions? Is the science involved in aeronautics different from that involved in astronautics?

Dr. VON BRAUN. Aerodynamic problems are quite important in rocketry and space vehicles, although of course, there are many other problems of at least equal importance such as electronics and rocket propulsion.

I think Dr. York answered this question very well when he said the most attractive thing about NACA is that it constitutes an assembly of exceptionally fine talent and great experience. If this talent and this experience and also the fine NACA facilities become the hard core of the National Aeronautics and Space Agency, then you have something to begin with and that alone has decisive advantages over forming a brand new agency from scratch.

Mr. FELDMAN. Do you have any ideas in connection with the provision in the proposal concerning an advisory group of 17 members?

Dr. VON BRAUN. I think I said at the beginning of my testimony that I feel that the charter of NACA requires some rather drastic changes to enable NACA to take care of the administration and the extensive managerial problems of an ambitious space program. From its present status as an advisory committee and a group of loosely connected institutes for supporting research, it must be transformed into an executive management agency capable of handling large contracts and supervising the allotment of large sums of money for them. This means, in my opinion, that the executive hand of the director of the NACA must be strengthened—so that he would assume a role comparable to that of a corporation president—and that the role of the present main committee of the NACA should be transformed into that of a board of directors, so to speak.

Mr. FELDMAN. Do you feel that there is anything in the organizational structure in Peenemunde that could be used beneficially in any project we might undertake or any new agency we might create?

Dr. VON BRAUN. The organization of Peenemunde, at least until spring, 1944, was very similar to our present operational setup in the Army Ballistic Missile Agency. There was a military commander and there was a completely civilian research and development division, and in addition there was a contract administration to handle the legal and fiscal portion of all outside contract work.

Mr. FELDMAN. The patterns are much alike?

Dr. von Braun. The pattern was very much the same. I would say, even to the extent that at Peenemuende, too, about 50 percent of the money was spent outside for industrial support, while the other 50 percent were spent in house.

Mr. Feldman. Dr. DuBridge of Cal Tech stated that manned satellites provide a program of a Buck Rogers variety, and the moon bases are just pseudomilitary expeditions. Do you have any comments to make on that observation?

Dr. von Braun. I have never expressed myself one way or another on the military significance of the moon. I believe it is at least premature to justify any moon flights at this time with a military necessity of establishing a fortress on the moon. In fact, I have grave doubts as to whether the moon really has, at this time at least, a military importance comparable to that of an artificial, orbital station in space. As to the military importance of such artificial, manned satellities I have not the slightest doubt that 10 or 15 years from now there will be large manned space stations, but I think they will mainly serve scientific purposes and for observation—both astronomical observations and also terrestrial observations, weather observation, weather forecasting and military reconnaissance. But I think in addition to these large, manned space stations there will also be smaller, more maneuverable orbiting vehicles of very great military importance, and in the not too distant future, too. And these vehicles will not only be suited for reconnaissance. No matter how skeptical other men have expressed themselves in this regard: I firmly believe they will play a most important military role as carriers for guided orbit-to-ground missiles.

I am convinced that 10 to 15 years from now, space priority will assume the role of today's air superiority.

Mr. Ford. Mr. Chairman, may I ask one question?

The Chairman. Yes.

Mr. Ford. In your discussion, you talked of shooting a man out into space 150 miles, using the Redstone vehicle. In time, if you got the go-ahead and money and otherwise, how long would it take you before such a project could materialize?

Dr. von Braun. Approximately 1 year.

Mr. Keating. That could be followed, could it not, by the transportation of several people in one of these capsules? That would be a natural development, would it not?

Dr. von Braun. Yes, sir. The Army feels that in the pattern of future fluid ground warfare there is a very definite need to use large ballistic missiles of several hundred miles range even for the transportation of troops and supplies to fighting areas surrounded by the enemy.

Mr. Keating. I do not want to involve you in any interservice matters, but is it not possible such a method of transportation of personnel in military operations by such capsules could well be more economical than transportation through the atmosphere by plane?

Dr. von Braun. Yes, sir; definitely, particularly when you consider the aircraft attrition rate in areas where the enemy may enjoy local air superiority. I think flying large quantities of troops by aircraft into such areas and parachute them down to the ground becomes pretty costly in terms of losses of life. Today's troop carriers are slow,

lumbering planes that are easy prey for modern fighter planes, and dropping troops by individual parachute into terrain held by a strong adversary has always been a dangerous thing, too. Ballistic missiles would land the men in batches of 20 or even 50, and the landing capsule would constitute quite a concentration of firepower.

Mr. FULTON. If you can go up 150 miles into the air in a capsule, then it becomes possible to say, why not direct it across the Atlantic Ocean. It is only a case of the amount of propellant you would put in.

How long would it take you then in one of those capsules at 150 miles altitude to cross the Atlantic Ocean?

Dr. VON BRAUN. Sir, this particular vehicle, the Redstone, which we proposed for that manned ascent to 150 miles altitude, could not do that. But with larger rockets, for example, our new family of ICBM rockets, it would be possible to do that. In fact, they could even put a man in orbit and retrieve him out of the orbit after he has gone around the earth several times.

Mr. KEATING. At what rate of speed would this manned capsule be propelled to go 150 miles up?

Dr. VON BRAUN. It would have an approximately 4,500 to 5,000 feet per second velocity at power cutoff, and it would almost come to a standstill at the apex of the trajectory. It would have again a speed of about 5,000 feet per second when it reenters the atmosphere.

Mr. KEATING. On the circumference of the earth, how much of an arc would he have traversed in this experiment you are thinking of?

Dr. VON BRAUN. We could conceivably shoot him straight up, but for recovery reasons it would be important to select a suitable landing site.

Mr. KEATING. How far would he actually travel?

Dr. VON BRAUN. We picked a landing site about 150 miles from the launching point.

Mr. KEATING. How long would that take?

Dr. VON BRAUN. The entire flight?

Mr. KEATING. Yes.

Dr. VON BRAUN. Approximately 12 minutes.

Mr. KEATING. If it was on a 3,000-mile basis, he could probably go across the ocean in 1 or 2 hours?

Dr. VON BRAUN. Less than that.

Mr. KEATING. How long then?

Dr. VON BRAUN. About 30 minutes.

Mr. KEATING. You have said that in 84 days you have been able to get a vehicle into orbit. Could you have done in less than 84 days if you had all the equipment, personnel and everything put into your hand with the instructions?

Dr. VON BRAUN. Are you talking about Explorer 1 now?

Mr. KEATING. Yes.

Dr. VON BRAUN. We needed 84 days because when we finally got the go-ahead we were told to quickly build a satellite—payload that included certain cosmic ray and meteor density experiments for the International Geophysical Year. It was simply the schedule for this new IGY payload that determined the time it took us to get Explorer I into orbit. Without that requirement we could have done it in half the time.

Mr. KEATING. So if you had not had specific instruction for the kind of rocket vehicle for Explorer I, you could really have put it up in about 40 days?

Dr. VON BRAUN. Yes, sir: but not because we are that good, but simply because we had the rocket hardware sitting around.

Mr. KEATING. Thank you very much.

Mr. McDONOUGH. On this so-called space vehicle or man-contained capsule, going to the apogee and then returning, does he return under gravitational force or with some propellant?

Dr. VON BRAUN. No, he falls back into the atmosphere from the height of 150 miles and reenters the atmosphere at approximately Mach No. 5. That is a speed of about 5,000 feet per second. From this initial reentry velocity he is then slowed down by atmospheric drag.

Mr. McDONOUGH. He has no control over his return flight?

Dr. VON BRAUN. No. A parachute will be deployed when, at an altitude of about 7,000 feet, his speed has become subsonic. The parachute slows him down sufficietly to land smoothly in the ocean.

Mr. McDONOUGH. There is no propellant in the capsule?

Dr. VON BRAUN. No.

Mr. McDONOUGH. It would mean he would be slowed by a parachute or other means?

Dr. VON BRAUN. Yes.

Mr. McDONOUGH. With your present plans and your present possibilities today could you direct his flight to the 150-mile elevation and land him at a specified point?

Dr. VON BRAUN. We could place his landing point within about half a mile from the ship which would fish him and his capsule out of the water.

Mr. McDONOUGH. Could he land on ground?

Dr. VON BRAUN. He could, yes; but it is simpler to land him in water.

Mr. McDONOUGH. Safer, also?

Dr. VON BRAUN. For a number of reasons.

First, the final impact is softer; secondly, in water you can cover a large surface area with a ship very easily. On land, if the thing hits a rock or boulder, impact conditions may be uncontrollable. If it lands in the boondocks it may be difficult to reach the landing point fast enough.

Mr. McDONOUGH. All of this could be done within what period of time?

Dr. VON BRAUN. One year.

Mr. McDONOUGH. One year from now?

Dr. VON BRAUN. One year from the word "go."

Mr. McDONOUGH. Thank you.

The CHAIRMAN. Thank you very much, Doctor. We are very happy to have had you with us. For myself and the entire committee, I express our sincere thanks.

The next witness is Dr. Theodore C. Merkle, head of the Research Division of the University of California Radiation Laboratory, Livermore, Calif., a facility of the Atomic Energy Commission.

Dr. MERKLE. The Radiation Laboratory is a contractor to the Atomic Energy Commission.

The CHAIRMAN. Doctor, we will be very glad to hear you.

STATEMENT OF DR. THEODORE C. MERKLE,[3] HEAD OF RESEARCH DIVISION, UNIVERSITY OF CALIFORNIA RADIATION LABORATORY, LIVERMORE, CALIF., CONTRACTOR TO THE ATOMIC ENERGY COMMISSION

Dr. MERKLE. Mr. Chairman, I have been asked to present at this meeting a few comments concerning the relationship which exists between nuclear propulsion schemes and chemical propulsion schemes. In particular, I would like to talk about the possibilities that nuclear energy offers in the traveling of large distances in space.

Before I begin, I would like to set the stage a little bit, if I have your permission. You have been talking about outer space. I was a little surprised to find out that you are considering picayune distances in the order of a couple of hundred miles. I would like more to talk about outer space as being that volume of space lying between the orbits of Mars and Venus.

As you know, the earth is intermediate between these two planets, very nearly, and the distances then which are to be considered are distances of the order of 50 million miles as the least.

It is certainly true that you can call a trip to the moon a flight into outer space and back again, but I do not believe that it is semantically correct to refer to a distance of only 100 miles into the atmosphere as a flight into space.

Now, travel over these very large distances that I have indicated, with rockets, requires a couple of things. I would like to mention what they are.

In the first place, to propel the rocket, we must have available a large quantity of matter to throw away. If you throw it away very rapidly, then the rocket goes in the other direction very rapidly. The quantity of matter I shall refer to as the reaction mass.

In the second place, you have to have a large quantity of energy to give to this reaction mass. That is, you have to spend a lot of energy to speed up this material you are going to throw away, usually from the rocket nozzle, and send it away from your rocket as rapidly as you can.

This point is not trivial because the more rapidly you throw the matter away, the bigger is the payload for the rocket. It is a matter of concern if you wish to move around in the solar system with any convenience at all that a fairly respectable fraction of the entire launching weight be payload rather than fuel and propulsion machinery.

Now, if we hold these few ideas in mind, I can now point out what the difference really is between chemical rocket schemes and nuclear rocket schemes. In chemical rocket schemes, the energy source and the material to be thrown away are one and the same. You combine gasoline, or what have you, with liquid oxygen or use some other suitable combination of chemicals. From this combination you get energy which heats the material and flings it out of the rocket nozzle.

The one advantage that a nuclear scheme possesses is this: In the nuclear scheme the material that is to be thrown away and the material which provides the energy are not the same things. This makes the nuclear rocket devices quite different from the chemical rocket devices. Let me illustrate.

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In a nuclear rocket, you would presumably, if you are talking conservatively, consider the fission rocket, that is a machine which somehow extracts energy from the fission of uranium 235 or plutonium or some other fissionable material, and this energy would be used in one way or another to accelerate the reaction mass that I mentioned a while ago, and thus give momentum to the rocket.

Now, one pound of uranium, if fully burned, will generate about as much energy as 1,000 tons of coal fully burned at the earth's surface. And therein lies the reason that many of us believe that before space exploration, in the sense that I an using the word "space," becomes fully practicable; it will be desirable, although not technically absolutely essential, to have the development of a nuclear energy source for rocket propulsion Just in that 1 fact, 1 pound of uranium is roughly equivalent to a ton of coal burned; then if we remember that in a chemical rocket we must carry along an oxidizer as well as a fuel, this will be approximately equavalent to 2,000 tons of rocket fuel Now, that gets me off the energy hook very nicely.

One can see that the power source that might be used to propel a rocket could consist of some type of fission reactor and the weight of actual fuel, that is the material that produces the energy that it must carry, would be a trivial part of the entire rocket dry weight. But I am still not off the other hook I still have to carry reaction mass in my rocket to throw away. So immediately the question becomes, how much of that will I have to have?

There is a relation between the speed that I give to a rocket and the speed at which I am throwing away material. The faster I can eject material from the rear of my rocket, the smaller the amount of material I must carry with me to get an equivalent performance. This is sometimes described in rocket language by a number which is called the specific impulse of the rocket, and the specific impulse of the rocket, when multiplied by the gravitational constant, for reasons I shall not go into, is just equal to the velocity of exhaust.

Now, the specific impulse of a nuclear rocket can be anything you care to name, if you build the right kind of rocket, which means in principle that so far as the velocity with which I eject particles is concerned, it is conceivable that one can set the velocity to any figure that is convenient and the convenience will be determined by other considerations than this particular law.

Now, what is practical?

What seem to be practical at the moment are two types of rocket proposals. One is called the heat-exchanger rocket. In the heat-exchanger rocket, we must imagine that we have a typical rocket nozzle and a large pressure vessel hooked onto it which looks something like a barrel. In this barrel there is the mass of a nuclear reactor, and there are a lot of holes drilled through it. The nuclear reactor generates heat at any rate you care to set. If you make it generate heat too rapidly, it will melt itself. So the rate at which you generate heat then in this barrel will be set by the amount of reaction mass you can push through the barrel

That reaction mass will be heated and ejected from the rocket in the same way that a chemical rocket functions.

Let me go over that briefly. The heat-exchanger rocket is the analogue of the large liquid fuel chemical rocket. The only difference is that the fire is contained within the body of the nuclear reactor and

is not provided by the combustion of propellants. The fire temperature will be limited by the kind of materials from which you can build this heat exchanger, as it is called.

Now, there are programs in this country to study such rockets. Unfortunately, the details are classified. However, it is possible to imagine a variety of temperatures, when considering what performance one would get, without going into classified areas. It is possible to consider temperatures as high as the melting point of the most refractory material known; whether this can be done or not is a classified matter, but that temperature for the most refractory material known would be (some of the carbides) above 3,000° Kelvin. That is not so hot as the flame in a chemical rocket.

But you don't have to throw away the same kind of materials that you do in a chemical rocket and because you have at your disposal the choice of material you wish to throw away, it is possible to get, or imagine that you can get, superior performance from this heat exchanger rocket relative to the chemical rocket. That is the simple scheme which in the trade we used to call "Old Pokey"; the Old Pokey rocket is the heat-exchanger rocket. This is the kind you read about in all the Sunday supplements, or have read about. It is the kind described in Russian literature years ago. It is the kind of scheme that has been talked about either in science fiction or elsewhere since about 1928.

The second scheme which appears to be practical is called the ion rocket. In this type of device, you wish to avoid the problems of the heat exchanger. To do that, we use a nuclear-energy source (and it has to be a nuclear-energy source because the demands are very heavy) to generate electricity in the rocket. This electricity is used to operate an accelerator, an accelerator characteristically giving about 2 or 3 kilovolts of energy to the particles that are to be thrown away.

Such an accelerator then can give a very high velocity to the particles you throw away, and therefore the amount of matter that you must throw away to achieve a given velocity is less than it otherwise would be.

There are, unfortunately, practical limitations at the moment which keep the ion rocket from being able to take off from the earth's surface. It is by its nature, and that nature is determined largely by the horsepower per pound that you can get in electric and turbo machinery, it is by its nature restricted to very low values of thrust. Therefore, it cannot leave the earth's surface by itself. However, such an ion rocket in principle can leave an orbiting space station and proceed to accelerate over very long periods of time so that it acquires quite high velocities, and with such devices you can calculate possible trips to such planets as Mars and Venus.

Actually, ion rockets can be imagined to go farther than that, but the length of time required for the journey begins to get rather long.

So these two schemes are the schemes that look most promising in the field of nuclear energy. One of them is being worked upon by the Los Alamos Laboratories on a classified basis. The other is being explored by a variety of people at a very low level, but so far as I know, a vigorous program for the development of such a thing has not yet been mounted.

Mr. McDonough Is there any Government program on any one of these?

Dr. MERKLE. The Los Alamos program is a Government program. The ion rockets studies that have been made so far have been in part under Government sponsorship and in part done by various people at their own expense. I would like, however, to make a few more comments.

The Old Pokey rocket, the one that Los Alamos is working on, is much nearer to fruition than the ion-rocket schemes. The ion-rocket schemes are a sort of evil gleam in people's eyes at the moment.

Mr. FORD. How do you spell ion?

Dr. MERKLE. I-o-n, a charged particle. The ion rocket schemes require a certain amount of very basic development in their components before they can be taken too seriously.

The Old Pokey rocket also requires certain basic developments in its components before it becomes a reality, but there is at least an order of magnitude difference in the difficultness of these problems. The Old Pokey rocket will get there first.

Mr. FORD. Is the distance between Old Pokey and ion because one is an old-fashioned affair?

Dr. MERKLE. At Livermore, we considered the Old Pokey rocket as the most stupid nuclear rocket you can cook up. It has only one advantage; it is very likely to work.

Mr. FORD. Why is it called stupid?

Dr. MERKLE. You see, it is not very imaginative. It is the sort of thing you would think of, just offhand in an idle moment. When you look at the numbers, it still makes a reasonable amount of sense.

The main problem in the Old Pokey rocket is obtaining materials that can stand up to a very rugged environmental condition, both from the standpoint of chemistry and from the standpoint of thermal stress. These materials appear to be on the horizon. The progress that has been made is classified, but there are no final conclusions as yet.

The ion rocket, on the other hand, has problems that are beyond just the materials problems. It is a matter of developing high-energy sources; there is a matter of developing very high-power density in reactors; there is a matter of developing a heat sink against which the heat engines of the reactors must run, because in space there is no way of getting rid of heat except by radiating it. All steam engines have to have a condenser some place in a closed cycle. In space that condenser or device that is equivalent will have to radiate energy away into space. This gets you into the materials problem business again.

So, for the ion rocket in addition to the ion source development, there is the heat-sink problem that has to be looked into and, last but not by any means the least, is the matter of highly reliable electrical components with a very good ratio of power to weight.

At the present time, standard electrical components on aircraft can be as good as a pound or so per horsepower. It would be very nice if this could be cut down to a tenth of a pound or so per horsepower.

There is no basic law that gets into one's way, but such development has not been pushed at the present time. For both the Old Pokey and the ion rocket, it is not clear how long a time would be required for doing the material developments.

On the other hand, there are no physical laws that we know of that say you can't do the material development. So I think it would

be fair to say that both schemes probably will, in the course of time, become quite practical.

This is a very brief introduction. I have mentioned what the main advantage is in using nuclear energy, and I have mentioned the two schemes which I personally believe have a chance of succeeding.

Now, what can you do with it?

I do not wish to give any testimony as to the possible uses for space exploration, military or otherwise. The kind of voyages you could manage undertaking with either of these schemes would be trips, as I mentioned before, to the two nearest planets. To the moon, one goes without saying, this just tumbles out of the thing almost automatically. This is a round trip sort of thing.

Mr. KEATING. At what speed?

Dr. MERKLE. The speeds vary. It depends on what you want to give the rocket in the way of a payload and how conveniently you want to return. The increment of velocity that must be given to the rocket is the usual figure of merit that is used.

For a trip to Mars and back, following a parabolic curve, the velocity that must be given to the rocket overall is about 24 miles per second, not an exorbitantly high speed. This can be compared to escape velocity from the earth, which is 7 miles a second. The reason for the large difference is that some of the delta V you give is used to slow down at the other end so that you don't fly into Mars in an uncomfortable way and can accelerate away from Mars again and brake coming back to the earth.

This gives you some kind of idea.

Mr. FULTON. Before you leave your general field, could I ask if you would comment on the photon propulsion?

Dr. MERKLE. The photon scheme as nearly as we are able to tell makes no sense whatever.

Mr. FULTON. Has any investigation been made on the use of light as a propellent?

Dr. MERKLE. Yes. It is a fairly easy thing to explore on a theoretical basis and a great deal is known about the behavior of photons. The big hooker is that the photon has very little momentum for a large amount of energy and therefore the materials that are doing the radiating of photons are exposed to rather extreme conditions if you wish to get any kind of acceleration out of the system at all.

Mr. FULTON. Your judgment is that that field is completely impractical?

Dr. MERKLE. I think that the noise that has been made about photon rockets has been made on a theoretical basis, considering only the photons and not how you got them in the first place.

Mr. McDONOUGH. Comparing the photon to the ion and Old Pokey, are the ion and Old Pokey still on a theoretical basis?

Dr. MERKLE. I would say Old Pokey is half theoretical and half practical by now. The ion scheme is theoretical but theoretical on a basis that is quite firm in that many studies have been made considering the entire problem, not just the problem of accelerating the ions, for example, but how you get the reactor, how you get the heating, how you make the ion sources and the like.

Mr. McDONOUGH. You are speaking of a source of power here and you are not considering the environment of the vehicle, of the man, the environment man will be in during this space travel, are you?

Dr. MERKLE. Let me see if I understand what you wish me to say.

Mr. McDONOUGH. Well, the condition in which he would be enclosed. He would be on a long trip. He would be traveling at 1,440 miles a minute, 24 miles a second.

Dr. MERKLE. That is not really correct. That is the velocity increment overall. His peak speed would be in the neighborhood of 8 or 9 miles a second.

Mr. McDONOUGH. Then on a trip to Mars at the closest point of 36 million miles and return, that is a long trip, is it not?

Dr. MERKLE. That is quite a long trip. As a matter of fact, it would take—with very highly efficient power sources which don't exist but might be developed—it would take 150 days.

Mr. McDONOUGH. He would have to be provided with some safe living conditions.

Dr. MERKLE. He would indeed.

Mr. McDONOUGH. You are not speaking of such things.

Dr. MERKLE. No, sir. I am speaking just of the power source. It would appear as follows. That the problem of containing a man, feeding him, nourishing, whatnot, is a more straightforward one than the problem of trying to find the propulsion machinery that will get him there and back again.

Mr. FULTON. Did you mean that 24 miles per second is accumulated velocity?

Dr. MERKLE. That is accumulated velocity, that is the total velocity. It is lost at certain points and gathered back at certain points.

Mr. KEATING. What is the advantage of the ion over Old Pokey?

Dr. MERKLE. The ion rocket has advantages over the Old Pokey if you can make it work, when you are considering fairly long trips such as Mars or Venus. As far as going to the moon and back is concerned, probably two stages of Old Pokey or a large number of stages of the chemical rocket would be more expeditious.

But if you wish to go to Mars and back, and if you look at the time required, you find sort of funny things. The ion rocket will accelerate for a long period of time and therefore can make the trip in a shorter length of time than it would be in the two-stage Old Pokey machine.

The principal advantage, as far as just theory is concerned, then lies in the possibility in the future of getting an ion rocket with a high enough specific power to get to Mars and back in 150 days instead of something like 970 days which you would calculate for the 2-stage Old Pokey scheme. Of that 970 days, by the way, 447 days are spent in waiting for the planets to get back in position so that you can make the return trip.

Let me mention one other thing. To my mind the important advantage and therefore the main reason for pushing into the ion rocket concept, even though it looks very formidable, lies in the question of this reaction mass I mentioned a while ago. For an Old Pokey nuclear rocket it is desirable to use the lowest molecular-weight material that you can for the reaction mass. The lighter the molecules of material you throw away, the faster they can go. Therefore, whenever anyone talks about space travel using Old Pokey rockets they always talk about using liquid hydrogen as the reaction mass. Now liquid hydrogen can be kept in very large tanks but to keep liquid hydrogen for 900 odd days in a tank of thin stainless steel

in view of possible small meteorities, and other things, is to a certain extent a little frightening. I don't think I would like to take that trip. I am not sure you could hold it for 970 days.

The ion rocket, on the other hand, can use more convenient materials. One convenient one is cesium. You can have this in the metallic state in space so that the fuel that you are going to feed into your ion rocket then consists of wires which you have in big spools and these are not very seriously damaged by waiting around.

Cesium is an element.

Mr KEATING. What is the atomic weight of cesium?

Dr. MERKLE. It is one of the alkali elements.

Mr. KEATING. The difficulty with the ion rocket, the greatest obstacle, is getting that off the ground.

Dr. MERKLE. I would not say that. The greatest obstacle is finding out how to build one. After you have built that there are two possibilities really. One is that it can be built on an orbit around the earth.

That is, you truck the materials to that orbit by means of large chemical rockets or large nuclear rockets and you construct this ion rocket on the orbit. The other possibility is that it is built on the earth and it is a second stage for a large chemical or large nuclear rocket, either one.

Mr. KEATING. That is what I was coming to, whether that would overcome the obstacle of getting it up.

Dr. MERKLE. That is correct.

Mr. KEATING. Then it would be either, as you say, assembled in outer space——

Dr. MERKLE. Near outerspace.

Mr. KEATING. I get your point. That is a feasible arrangement?

Dr. MERKLE. Well, it is a manageable arrangement. Now this brings me to the next point I wish to discuss.

Mr. FULTON. Cesium is actually in practical use today in the atomic submarine, is it not?

Dr. MERKLE. Cesium is used in many, many places. It is an active alkali element. It oxidizes rapidly. You normally have to keep it in oil. By the way, don't let me scare you. You don't have to use cesium.

Mr. McDONOUGH. What is the difference in atomic weight of that and hydrogen?

Dr. MERKLE. Enormous. The main point is that you accelerate this cesium in an accelerator which gives it an exceedingly high velocity.

Mr. McDONOUGH. But it is much heavier.

Dr. MERKLE. I wish I could remember that property of cesium. I think it is in the neighborhood of 150 but it is much, much heavier than hydrogen and you make up for this heavy mass by giving it a high velocity. The thing that limited you in the Old Pokey was that there was a fixed temperature in the heat exchanger and therefore highmass particles achieved only a low velocity.

If you were to run cesium through an Old Pokey it would be utterly worthless for that reason. If you had at your disposal the voltage in accelerator tubes then you could set that for each material and it only has to be 2,000 volts to give cesium a specific impulse of about 6,000, which is considerably above anything that you can

do with Old Pokey and about a factor of 10 or 12 more than you can do with the most manageable exotic chemical fuels.

You really get a high specific impulse with the ion rocket.

The CHAIRMAN. The Chair recognizes Mr. Sisk.

Mr. SISK. Mr. Chairman, I have been particularly interested in Dr. Merkle's background in his work at the laboratory. I have been concerned with some practical applications of your knowledge and to what extent the programs are underway at present in the applied use of nuclear power in missiles or in a potential space vehicle.

Let me ask, in view of the discussion you just had with some of my colleagues, is there a laboratory doing work on this system?

Dr. MERKLE. This is something I wanted to take up here as a general heading. Maybe I shall do it as an answer to your question. The point I want to stress is that I am not talking about what you can build next year or the year thereafter; these systems are not schemes which enable you to get something into space as soon as possible. For that chemistry has to be used, it is already here, it is already being. The Old Pokey rocket presumably could become operational then in a period of time like 5 to 10 years. By operational I mean you could have one operating, not that there would be a whole lot of them.

The ion rocket will take somewhat longer, so that I am actually talking now about things that you will probably seriously want a decade from now. I bring this up because if you want them a decade from now you will have to start basic laboratory work and keep it rolling steadily for that whole time.

Mr. SISK. That is the point I want to bring up. As I understand, there is no work going on at the present time in laboratories on this. I think probably there should be. That is the thing I am interested in. If we want it a decade from now or 20 years from now, how are you going to get it if you don't get work started?

Dr. MERKLE. There is a lot of work going on now on the Old Pokey rocket, as you know. At Los Alamos there is a sizable program. Ion rockets are not quite so well thought of because they present much more difficult problems.

I believe that some feelers have been put out by a variety of agencies doing work on the ion rocket business and there are in fact some studies being made currently at the request of Government agencies.

Mr. SISK. Do you feel it is too early to start laboratory work on this program?

Dr. MERKLE. On a rocket, on an ion rocket?

Mr. SISK. Yes.

Dr. MERKLE. On an ion rocket per se—let me make a distinction between the research you have to do before you say what you ought to undertake and the development you must do after you know what you want to undertake.

I think the ion rocket comes in the category of things that might profitably be researched until you know whether you want to do it or not, and at how rapid a rate.

Mr. SISK. How much basic research is going on now in the ion rocket?

Dr. MERKLE. I do not know, but it is small.

Mr. SISK. With reference to your particular laboratory, of course, I am interested in Project Rover. What is its status?

Dr. MERKLE. Project Rover exists at the Los Alamos Laboratory. It does not exist at the Livermore Laboratory. It was discontinued there in January 1957.

Mr. SISK. Why?

Dr. MERKLE. We were instructed by the Atomic Energy Commission to discontinue this work and the reason they instructed us to do so was because there was not sufficient money authorized by the Bureau of the Budget to support both Los Alamos and Livermore in the Rover project.

Mr. FULTON. It was purely a money matter.

Dr. MERKLE. So far as I understand, this was purely a money matter. This was pre sputnik that this decision was made.

Mr. SISK. In order to bring us up to date, was there not something special within the last year or so on a new start in your Laboratories?

Dr. MERKLE. Livermore acquired Project Pluto in place of Project Rover. Project Pluto is a nuclear ramjet project. It is for military application strictly.

That project has absorbed the efforts of the people that used to be on the Rover project. There has been no question about reopening the Rover project at Livermore, to my knowledge.

Mr. SISK. Dr. Merkle, in view of the fact that the program is operating in the Laboratory at the present time, do you agree it should not be or do you think work should be going forward on it?

Dr. MERKLE. This is a question that really involves a matter of policy. I am not in a position to evaluate the Nation's policy on how much money should be spent on nuclear rocket development at this stage. I just do not know the answer to that question.

Mr. SISK. I appreciate that but I got the impression you felt we would not be able to go into outer space as such—I am speaking now of going into millions of miles—until there is either a program such as you have outlined or something similar where nuclear propulsion is used, that it would not be feasible; is that correct?

Dr. MERKLE. I think I would qualify that statement a bit. You can get to Mars using chemical energy if you want to but it is going to be a very, very inconvenient and costly thing to do.

I had hoped Dr. von Braun would be here to comment on this point because he has studied that matter a little bit.

Fairly extensive schemes are required to get chemical rockets to go to Mars and also back again. Let me put it this way: If you want to get to Mars or Venus at all conveniently, it will be necessary to use nuclear energy.

Mr. SISK. Would you like to be doing some work on this?

Dr. MERKLE. Personally, you mean? Certainly.

Mr. SISK. I am concerned with whether or not we are doing the things that we should be doing in looking ahead. We have heard criticism here because we had not put other programs into being soon enough. I do not want to be responsible for neglecting basic research in this particular field which might put us, let us say, 5 or 20 or 50 years behind. I am concerned with your thinking in the matter because I know you have knowledge of importance.

Dr. MERKLE. Let me answer that statement as follows: I think you have a very fine program at Los Alamos on the heat-exchanger-type rocket. One I have been facetiously calling Old Pokey.

At Livermore you have the program on Pluto, which is a nuclear ramjet. Now a lot of problems of the nuclear ramjet are similar to the problems of Old Pokey. So in a sense the work at Livermore will apply to very high temperature developments, powerplants, be they for ramjet engines or be they for rockets.

So we do not feel that we are entirely out of the picture. At the two Laboratories we have a considerable amount of effort being expended and I think an appropriate amount being expended on the development of reactors for these applications of the Old Pokey type. When I say an appropriate amount, by the way, I assume that the 1959 budget will contain what we all have asked for.

If it does not, then the amount is very inappropriate.

Mr. SISK. Do you feel, or do you have any knowledge, that the Russians may be working on nuclear propulsion?

Dr. MERKLE. That has bothered me a great deal. Everything that went into our studies on Old Pokey was derived from handbooks and whatnot that have been available since 1945. I do not know of any reason why the Russians should not be developing nuclear rockets or ramjet engines of the Old Pokey variety, that is the heat exchanger variety.

On the other hand I have no specific intelligence information that tells me they are. There are some releases that have been made in Russian journals of a popular sort which claim such things are being developed but the releases were technically not very complete and it was difficult to judge whether they were releases that covered up something deeper or whether they were the Sunday supplement type of thing.

Mr. NATCHER. Dr. Merkle, on Monday of this week our chairman, Mr. McCormack, introduced a bill H. R. 11881. This bill provides for research in the problems of life within and outside the earth's atmosphere and for other purposes.

Have you had a chance to read this bill?

Dr. MERKLE. I have not had a chance to read that bill.

Mr. NATCHER. There is one provision in the bill I would like to read to you and ask you how you feel about it. It provides that—

> The Congress further declare that such activity shall be directed by the civilian agency exercising control over aeronautical and space research sponsored by the United States except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations in which case the agency may act in cooperation with or on behalf of the Department of Defense.

Based on your experience with the Atomic Energy Commission, how does that provision sound to you?

Dr. MERKLE. Our relations with the Atomic Energy Commission at Livermore have been excellent. I do not see why an agency patterned in a similar way, no matter how it might be formed, to the Atomic Energy Commission should not work quite well in space development.

Mr. NATCHER. In other words, you feel that such a program as this particular program could be and should be directed by a civilian agency?

Dr. MERKLE. There are advantages to this. I am speaking now of the nuclear rocket-type program. For the chemical rockets there exists already so much hardware developed in the military programs that it is another matter altogether I imagine.

Mr. SISK. Mr. Chairman, I have just one concluding question. Do I understand you to say that the nuclear propulsion method has any particular application at present to the ICBM?

Dr. MERKLE. I made no statement at all about the application of nuclear propulsion to the ICBM.

Mr. SISK. I stand corrected then. I am concerned as to whether there are possibilities in the use of nuclear propulsion in ICBM's. I am also concerned whether this might provide a way of say, leapfrogging some other power in the world today.

Dr. MERKLE. You see, I am very prejudiced and therefore I cannot give you an honest answer to this. As I mentioned before we have at Livermore, Project Pluto. I have a lot of faith in Pluto. I think it will put the ICBM's out of business, but it is not a nuclear rocket.

Mr. SISK. I realize we may all be prejudiced at times, Doctor, but if Congress has some knowledge of the potential that exists, I think that it might be well to do something about appropriations, do something about the changes in these programs.

Dr. MERKLE. It seems to me that it certainly is true if you are talking about liquid propellent rockets, that a nuclear rocket ultimately might be able to outperform a chemical rocket, or do the same job for less money in the ICBM field.

What type of nuclear rocket this would be or when you could get such nuclear rocket I do not know. But the same arguments I used a while ago, having to do with the fact that you can separate the reaction mass from the source of energy, apply also to the nuclear rocket for ICBM's, only not quite so spectacularly as they apply when you wish to go far away from the earth.

Mr. SISK. But you do agree that research might be profitable in this field?

Dr. MERKLE. It might very well be; yes.

Mr. SISK. Thank you.

Mr. FULTON. Is there a limitation on the development in the use of nuclear rockets because of the danger through the discharged materials?

Dr. MERKLE. If you fire nuclear rockets, the least of your worries would be the material that is discharged from the reactor. That is, if you are in a shooting war and you are firing bombs, clean or dirty, the radioactivity dumped into the atmosphere by those weapons will be considerably greater than the amount which can conceivably be put into the atmosphere by any kind of nuclear rocket. From the standpoint of fission fragments and the like, the amount of material that is burned is about a tenth of a percent, or of that order, if you make a calculation just based on energy, not going into the size of rocket or any other classified business, of the fissionable material carried. This is a very modest amount of fissionable material.

I think the way it is commonly said is that any warhead test, for example, at Eniwetok or Nevada, makes considerably more fission fragment release than a nuclear rocket would.

Mr. FULTON. So you see no danger from either the testing of nuclear rockets being added to the current nuclear testing, nor do you see a danger through the practical use of nuclear rockets later?

Dr. MERKLE. As far as increasing the total burden of radioactivity in the earth's atmosphere is concerned I don't see any such danger at all.

The CHAIRMAN. Have you completed your statement, Doctor?

Dr. MERKLE. I believe I have covered all the topics I wish to, so I am open to questions, I guess.

The CHAIRMAN. The members started asking you questions and I did not know whether you had expressed your full thoughts.

Dr. MERKLE. I think I have expressed the thoughts that I brought here today for this purpose: One having to do with where does nuclear energy fit into this picture of space travel, and the other that it will be a long time before you have space travel with nuclear power. We should maintain a uniform program if we expect to get there at all.

I would like to go along with the other two gentlemen who testified today in making very clear that I believe the stability of laboratory programs is exceedingly essential if reasonable progress is to be made most efficiently.

For example, at Livermore we have felt the effects of violent fluctuation in nuclear propulsion programs and those effects were not good. They have cost the programs in question quite a bit of time. The turning off and turning on is not a good way to get laboratory results by able people. In fact, it is a very bad way. So I think that if this committee is interested in seeing the United States maintain a lead in the development of nuclear energy for application to space travel, and for application to bombardment missiles of all sorts, be they ICBM's driven by nuclear energy or be they Plutos—the important thing to do is arrange for a funding over periods like 5 years that will be steady and predictable. Turning such a thing off and turning it on is just simply murder to a group that is doing the work.

Mr. MCDONOUGH. Dr. Merkle, what is the presently known thrust possibility of a nuclear rocket?

Dr. MERKLE. This question of thrust has been kicked around a lot. I would like to make something plain. Thrust in itself does not mean a great deal. It is related to the amount of payload that you can carry. Thrust per unit payload carried is probably the quantity you might like to talk about. A nuclear rocket could have any thrust under the sun. It depends on how big a one you build. That is also true of the chemical rocket. The thrust you can get depends upon how big a one you can build.

Mr. MCDONOUGH. Is it possible that the thrust Russia has is from nuclear power?

Dr. MERKLE. I don't think so. You see the important thing in a high-performance rocket is not just its thrust but the speed at which the exhaust gases are thrown out. There is a relation between the thrust and the power and the specific impulse and it goes like this. Thrust is always equal to twice the power divided by the specific impulse multiplied by gravitational constant. Thrust is equal to twice the power divided by the exhausting velocity of the rocket.

Now if you want to have a system with a very high thrust you can get the thing two ways. One way is to have a very high power, the other way is to have a very low exhausting velocity. But if you do it with a very low exhausting velocity you will have a high thrust all right but your rocket will not go very far, you will run out of fuel in a hurry.

So thrust alone is not the figure that you would like to use.

Mr. MCDONOUGH. What is the ratio of thrust in pounds to payload?

Dr. MERKLE. If you imagine for the moment a system that has a specific impulse of 800 seconds, which is pretty high (it is about twice as high as you can get with super chemicals) then you can put about 30 percent of the launching weight of that machine into payload and structure, which means that you will have 15 percent or so in payload. If that specific impulse was 200 seconds you would have something in the neighborhood of one-twentieth of the launching weight in payload, something of that order.

Mr. McDONOUGH. Now if you had a nuclear-propelled spaceship in operation beyond the atmosphere of the earth, beyond terrestrial gravity——

Dr. MERKLE. There is no such place.

Mr. McDONOUGH. Yes.

Dr. MERKLE. Gravity diminishes inversely like the square of the distance.

Mr. McDONOUGH. But the pull gets less.

Dr. MERKLE. The pull gets less but it does not vanish.

Mr. McDONOUGH. You mean after we get beyond that you get within the gravitational field of another planet.

Dr. MERKLE. The thing that really gets into your hair is the gravitational pull of the sun. You see, after you pull a fair distance away from the earth then you begin to feel the pull of the sun more strongly than the pull of the earth.

Mr. McDONOUGH. Is it possible that such a ship would be drawn into the sun?

Dr. MERKLE. If it did not have power that is what would happen to it.

Mr. McDONOUGH. And it could not go in any other direction?

Dr. MERKLE. No. Unfortunately the sun pulls in all directions pretty uniformly. So you have to be able to fight off the Sun's gravitational field if you wish to go from the Earth to Mars.

Mr. McDONOUGH. Do we know that a nuclear-propelled spaceship will operate efficiently at the maximum distance from the earth, the earth's gravity?

Dr. MERKLE. The gravitational pull of the earth in no way affects the operation of the rocket. All the earth's gravitational field does is sort of reach out and pull back on the whole system.

Mr. McDONOUGH. If you were ready to go, and had all the equipment to go, to Mars, how could you avoid orbiting the earth?

Dr. MERKLE. This statement is a little bit hard for me to understand, the picture you have in your mind.

Mr. McDONOUGH. I mean, if you started off from the earth and you wanted to go directly to Mars, how could you prevent the earth's gravity causing an orbit around the earth, from bringing the ship into an orbit around the earth?

Dr. MERKLE. The way you can prevent that is to keep increasing the velocity of the rocket until it goes where you want to have it go.

Mr. McDONOUGH. That means, then, as you leave the earth you must increase your power and keep on increasing your power?

Dr. MERKLE. No; the power does not increase. Let me put it this way. There are two ways in which you can get an object away from the earth. One way would be to give it a terrific wallop very near the earth. This is what the big chemical rockets do. This is what the Old Pokey scheme would do. You give it such a terrific

wallop that it goes to wherever you want it to go. It keeps going slower and slower as it goes there because of the earth's pull but finally it gets way out to where you want it to be. If you don't do anything about it, it will fall back in toward the sun. If the earth gets in the way, it will run into the earth.

The other way to do the same job is to put a more gradual push on it but keep it on for a long period of time. That is what the ion rocket does. Both schemes result in giving a rather large velocity to the rocket and incidentally when you shut the power off if you are not going fast enough you will fall back into the sun but it is possible to build a velocity so high that you would keep going away from the sun, even so. Escape velocity from the sun if I remember correctly is about 25 miles a second.

Mr. McDONOUGH. Do we know what the gravitational pull of Mars is?

Dr. MERKLE. Yes; indeed.

Mr. McDONOUGH. When this ship comes within the full effect of that gravitational pull, then you have to have a reverse effect?

Dr. MERKLE. Yes; if you wish to make a landing on Mars you would then have to brake as you fall in toward Mars. This is why you carry a lot of extra propellant with you.

Mr. FULTON. On those points of velocity, if you left the earth's surface at sunrise you would then be able to go to the moon with increased velocity and you might then, by leaving the earth's surface at sunset, use the gravitational pull of the sun to get to whatever planet you want; is that right?

Dr. MERKLE. Near the earth the pull of the sun is smaller compared to the pull of the earth so you really cannot take much advantage of that. It is a nuisance to you, not much help.

Mr. FULTON. Once you get away from the earth you could not use the sun's gravitational pull to get to a planet nearer the sun?

Dr. MERKLE. It would change the situation a bit and the sun's gravitational pull helps you on a trip downward to Venus, so to speak; "down" being toward the sun, but it would get in your hair on the way "up" from Venus.

Mr. FULTON. Could I have you compare the nuclear-type rockets and the chemical-type tockets fuelwise to the present fuel systems we have?

For example, take the liquid propellants that require an oxidizer. That is the first stage of the Vanguard. Second, would you compare the fuels that ignite on contact in the second stage of the Vanguard; and third, would you compare them with the solid fuels?

Dr. MERKLE. Unfortunately the specific impulse that we feel that we can achieve with nuclear rocket is classified. So I can't really make a comparison of known chemical performance against speculative nuclear performance and have it mean much for this particular meeting. I can make a sort of general statement.

Mr. FULTON. I would rather not risk classification.

Mr. SISK. I have just two questions. It is my understanding, Dr. Merkle, that Dr. Norris Bradbury made a statement that he felt it would be easier to develop and construct a nuclear-powered rocket or an ICBM than it was to develop the atomic bomb or the hydrogen bomb.

Do you agree?

Dr. MERKLE. You are trying to compare apples and beans, or something, there. It is rather hard to say whether an apple or a bean is hard to digest or something like that.

Mr. SISK. I was curious to know whether you were familiar with Dr. Bradbury's estimate and if so, whether or not you agreed.

Dr. MERKLE. In the first place I am not familiar with the statement. I believe I have heard a rumor here or there. In the second place I do not know in what context he was talking and therefore I don't know why he was trying to make a comparison.

All technological problems are difficult. It is my feeling that they are all equally difficult because people mostly work just as hard as they can, they do what they can do. Both of these things will turn out to be as possible, I believe, as the atomic bomb and the hydrogen bomb.

Mr. SISK. Dr. Merkle, will you comment on the control of thermonuclear energy? I realize it is probably somewhere in the future, but will you comment on the likelihood of it, its asset, the application of it to space travel.

I think Dr. Bradbury at Los Alamos has made some comments on its use in space travel.

Dr. MERKLE. I will make a comment about it. To date nobody has succeeded to my knowledge in obtaining thermonuclear reaction under controlled conditions.

To make estimates as to what the weight of a powerplant that does not exist might be per unit power developed is difficult. In the field of rockets it is terribly important to know what the specific power of any system you propose to use will be.

That is to say, how much horsepower per pound you can get. I have no idea what the thermonuclear systems might look like, if indeed they work at all. I believe Admiral Strauss has made the statement publicly that he thinks it will take at least 20 years to get the thermonuclear business under control.

I see no reason to quibble with that statement.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Doctor, does the problem of metallurgy in connection with the development of a nuclear power used for rockets have any great importance?

Dr. MERKLE. The problems of materials in general are of crucial importance in the development of nuclear reactors for propulsion purposes, particularly space-propulsion purposes. I think it would be wrong to restrict the field to metallurgy. The field of ceramics is also involved, as well as the field of so-called hard metals or the carbides.

Mr. FELDMAN. Would the problems be similar to those encountered in the development of the *Nautilus*, the atomic submarine?

Dr. MERKLE. I think the problems in materials, where involved in nuclear propulsion for space travel, are more severe than the problem encountered in developing the *Nautilus*.

Mr. FELDMAN. Has not cesium, for example, developed as a result of the *Nautilus* program?

Dr. MERKLE. I would not say so. It has been known for a good many years.

Mr. FELDMAN. But it was developed so it could be used in connection with——

Dr. MERKLE. I think what one is doing here is grasping at an individual element. Let me put it this way. To use nuclear reactors for propulsion purposes will require exceedingly high temperatures, no matter how you do it. The *Nautilus* does not have to develop exceedingly high temperatures in order to be a practical device. What we are faced with in nuclear propulsion for ramjet or nuclear rockets is chemistry that is about as unknown as general inorganic chemistry was unknown in 1800.

Mr. FELDMAN. How about the zirconium technique? Did that not evolve during the time they developed the *Nautilus*?

Dr. MERKLE. There has been a lot of work in zirconium metal and its compounds for reactors, not only for such things as fixed powerplants but also for possible portable ones, largely because zirconium happens to have very low capture cross section for neutrons.

I would not say that zirconium resulted from the *Nautilus*.

Mr. FELDMAN. Would you say the great ability to produce U-235 in this country would give us an advantage over the Soviet Union in nuclear propulsion?

Dr. MERKLE. Since I have no idea what the Soviet Union's reserve of uranium may be I cannot really answer that question.

Mr. FELDMAN. We have more electricity than they have; is that right?

Maybe then we can make more U–235.

Dr. MERKLE. I see what you are driving at. I do not know if that follows either. The important thing is how much ore do you have? If they wish to devote a large electrical capacity to manufacture, I suppose they can.

But I really cannot comment on this subject because I have no knowledge at all of Soviet capacity for electricity or Soviet capacity in uranium.

Mr. FELDMAN. I have no further questions.

The CHAIRMAN. Are there any further questions?

Thank you very much, Doctor. We appreciate your presence.

It has been very helpful and for myself and the committee I express our sincere thanks.

Dr. MERKLE. Thank you very much, Mr. Chairman.

The CHAIRMAN. The committee stands adjourned until tomorrow at 10 o'clock.

(Whereupon, at 5:05 p. m. the committee adjourned, to reconvene at 10 a. m. Wednesday, April 16, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

WEDNESDAY, APRIL 16, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION,
Washington, D. C.

The committee met, at 10 a. m., pursuant to recess, in the Caucus Room, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack (chairman), Brooks, Metcalf, Natcher, Sisk, Arends, McDonough, Fulton, Keating, and Ford.

Present also: George J. Feldman, Director and Chief Counsel.

The CHAIRMAN. The committee will be in order.

The next witness is Lt. Gen. D. L. Putt, Deputy Chief of Staff for Headquarters, United States Air Force.

We are very glad to have you here before us, General Putt. You may proceed.

STATEMENT OF LT. GEN. D. L. PUTT,[4] DEPUTY CHIEF OF STAFF FOR DEVELOPMENT, HEADQUARTERS, UNITED STATES AIR FORCE; ACCOMPANIED BY DR. HUGH L. DRYDEN, DIRECTOR, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, AND PAUL G. DEMBLING, GENERAL COUNSEL OF NACA

General PUTT. Thank you, Mr. McCormack.

Mr. Chairman and members of the committee: It certainly is a pleasure for me to appear before your committee today. I am honored that you have seen fit to solicit my views in this important initial phase of your operation.

As I understand the situation, your immediate purpose is to establish a general framework for your overall investigation of space research and exploration and to identify the major problems involved.

Later, I see from your schedule, that you will call Air Force technical experts like General Schriever, who heads up the Air Force ballistic missile and satellite programs, and General Keirn, who is my top staff assistant for nuclear matters.

Likewise, General Boushey for astronautics, and perhaps others like Dr. Strughold from the Air Force Space Medicine Laboratories.

Therefore, I will leave the details to them and keep my remarks in a more general vein.

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[4] Putt, Donald L(eander), air force officer; born Sugarcreek, O , May 14, 1905; s. Harry Edwin and Lucy Hollis (Preslar) P ; B. S. in elec engring , Carnegie Inst. of Tech., 1928; M. S. in aeronautical engring., Calif. Inst. of Tech , 1938, Air Corps Engring. Sch , 1936–37; m. Margaret Wile Yent, Dec. 27, 1933; 1 son, William Donald. Enlisted July, 1928; commissioned 2d. lieut , 1929; advanced through grades to maj. gen , 1949; stationed with 1st pursuit group, Selfridge Field, Mich , 1929–33; flight test pilot, Wright Field, 1933–36, chief bombardment branch, Engring Div, 1938–45, dep. comdg. gen., Intelligence, Air Materiel Command, 1945–46, dep. chief, engring. div , 1946–48, dir Research and Development, U. S Air Forces, 1948–52; v. comdr., Air Research and Development Command, U. S A. F., 1952–53, comdr , 1953–54; dep. chief of staff, development, Hdqrs USAF, 1954—; dir. tech. services, Air Tech. Service Command, Europe, 1945. Decorated Legion of Merit with Oak Leaf Cluster; Bronze Star Medal with Oak Leaf Cluster; Croix de Guerre with Palm (France). Mem. Inst. of Aero. Scis., Nat. Adv. Com. for Aeronautics, Nat. Inventors Council, Sigma Alpha Epsilon, Tau Beta Pi, Theta Tau, Eta Kappa Nu, Sigma Xi, Scabbard and Blade. Home: Quarters 68, Bolling Air Force Base, Washington. Office: Hdqrs. USAF, Washington 25.

On that basis, I should like to discuss three areas of immediate concern. They are:

1. Reasons why our country should undertake a national space program as a matter of urgency;
2. Logical agencies to manage and be responsible for implementation of our national space program;
3. And some of the space exploration tasks we must place particular emphasis on.

First, why should the United States undertake a national space program with such urgency?

I could not improve on the basic answer laid down by the Scientific Advisory Committee to the President in its document, Introduction to Outer Space.

Dr. Killian's group pointed out it was useful to distinguish among four factors which give importance, urgency, and inevitability to the advancement of space technology.

Foremost among those factors was the compelling urge of man to explore and discover—to go where no one has gone before. This characteristic of man has played an important role in the advancement of civilization since history began.

Now that many of the secrets of earth and its atmosphere have been ferreted out, it is only logical that man would turn to outer space.

Another factor was the opportunity for scientific observation and experimentation. We will learn more about the earth, the solar system, and the universe. Undoubtedly, mankind will benefit from new and amazing discoveries. While all of the benefits to accrue from the exploration of space are not crystal clear at this time—as is the case with any early research, discovery, and exploration—they have consistently paid off in betterment of the human race. I have no doubt but that our efforts in space technology will yield returns as great or greater than many significant explorations of the past.

Still another factor was that of national prestige. If we are to lead the world to peaceful ways, if both our friends and potential foes are to listen with respect, then we must lead not only in industrial, economic, and military strengths, but in science and technology as well.

And, lastly, the defense objectives for the development of space technology were pointed out. Dr. Killian's report pointed out that we wished to be sure that space was not used to endanger our security. It is in this area that I should like to add my thoughts.

It appears most important that our Nation and its allies win and maintain the capability to control space in order to assure the progress and preeminence of free countries everywhere. If liberty, freedom, and justice are to prevail for all peoples, we cannot permit the dominance of space by those who say they will bury the United States.

You will note I have stated that the United States should win and maintain a capability, and I repeat the word capability, to control space.

I do not say that we must exercise control of space, but we must have the capability to do so. There is an important distinction between the two.

We in the military fervently hope that all nations join together in whatever measures need to be taken to insure that space is never used for any but peaceful purposes.

But until international arrangements are made that assure this objective, our possession of the capability to control space would guarantee liberty of the free nations and not deny the anticipated benefits of space to others.

Freedom in space might be considered analogous to freedom of the seas. In the past, when the military capability to control the seas was exercised by peaceful nations, people everywhere profited.

The military capability to control space insures its advantageous use for nonmilitary purposes, which, of course, is our ultimate goal.

Further, I am positive that increased knowledge of space will open a new vista of scientific plenty that will benefit people throughout the world. For example, I should like to mention two military space vehicles which also have beneficial peaceful uses.

The first of these is the reconnaissance satellite for surveillance and mapping the surface of the earth. Eyes in outer space will keep us informed of military movements on the earth's surface. Mapping accuracy will be increased greatly, military targets throughout the world could be plotted for greater accuracy. We would have almost immediate warning of hostile action anywhere on the surface of the earth. This, in turn, would permit much faster reaction on our part.

On the other hand, it could be a powerful instrument for peace in the implementation of any inspection system or "open skies" policy. Further, the reconnaissance satellite should prove a boon to weathermen everywhere.

Thousands of lives and many dollars could be saved by precision forecasts of hurricanes, typhoons, and other severe weather. Worldwide study of the energy imbalances surrounding our earth might provide the first real clues to weather control. Certainly, long-range seasonal forecasts can vastly improve the productivity of resources from the earth.

Even the farmer could benefit from improved weather forecasting resulting from reconnaissance satellites.

The second vehicle with peaceful, as well as military application, is the communications satellite. At present, all transoceanic communication is by costly cable or by shortwave radio, and the latter is often disrupted by solar disturbances.

With the present state of the art, television can be beamed only a few hundred miles and is limited to line-of-sight distances. Several suitably equipped and located satellites could serve as radio and television relay stations, able to receive signals from any point on the earth and relay them either directly or via another satellite to any other point. Solar or nuclear energy power sources could give them useful lives of many years.

Better understanding between the nations of the world has always followed improved communications in all forms.

When we have the added capability to send man to and from these communications satellites for maintenance and perhaps operating purposes, their usefulness will reach a tremendous peak of efficiency. The value of such satellites for long-range military communications purposes are so obvious that I need not dwell on that subject.

As we go farther out into space, it is a certainty that additions to our knowledge will bring forth valuable, and as yet undreamed of, practical applications to man's well being. But the benefits to be

gained through our knowledge and use of space are apt to be dependent upon our ability to control space.

As an airman, I have long since learned that the capability to control the air above the earth's surface permits freedom of movement on the land and seas beneath.

As we progress into space, I feel sure that our capability to control that medium, or selected portions thereof, will assure freedom of movement both on the surface of the earth and through the earth's atmosphere.

Next, let me turn to the area of management and implementation of our national space program.

Too often in our history the solution to new and vexing problems has been to create new organizations that add to the Federal overhead cost, but really do little to alleviate the situation.

At one point in the almost hysterical reactions to Sputniks I and II, it seemed that space technology would somehow be considered an entirely new kind of military and scientific mission. That approach could have had only 1 of 2 results, either a new and fourth military service for all practical purposes and/or new governmental scientific agencies, or fierce competition among existing services and agencies for the space mission responsibility.

But, as is frequently the case, the solution was at hand. Perhaps, because it was so simple, people were reluctant to advance it for consideration.

I am glad to see that reason has prevailed and we have come to the realization that the necessary tools are already at hand in governmental agencies, science, and industry. The real problem is actually one of work selection and coordinated direction. In other words, effective management.

First of all, I feel the Congress is to be congratulated on the forthright manner in which both the House and the Senate have accepted their responsibilities to the American people for space technology. I am confident that this committee, and its counterpart in the Senate, will, at the end of its deliberations, provide the guidance necessary to insure preeminence of the United States in the space world.

The establishment of the Advanced Research Projects Agency in the Department of Defense is a large stride in the direction of adequate military management in the space age. At the same time, the temporary assumption by this agency of our national space program, while proper procedures and responsibilities are worked out in sensible fashion, will help insure that we lose no more time in this race for the conquest of space.

I am sure the ARPA will make valuable future contributions in the vital matters of establishing worthwhile projects, setting priorities, coordinating efforts, and guiding the many participants in these undertakings.

The action, however, that is the most logical to me, is the legislative proposal to the Congress calling for the redesignation of the National Advisory Committee for Aeronautics as the National Aeronautics and Space Agency with a commensurate increase in functions, responsibilities, and authorities. This is the action that I referred to as being at hand, but perhaps so simple that people were reluctant to put forth such a proposal.

The Air Force fully supports this proposal in principle.

It is logical from many viewpoints. The basic charter of the NACA states:

to supervise and direct the scientific study of the problems of flight with a view toward their practical solution.

And in discussing space technology, it should be recognized there is no division, per se, between air and space. For all practical purposes air and space merge, forming a continuous and indivisible field of operations. Thus the NACA already has great responsibility in the astronautics sciences.

There has been and still is evidence of efforts to isolate astronautics and aeronautics. This separation is impractical, if not impossible, and can only lead to confusion.

Any ventures we make into outer space must be based on the foundation or knowledge already accumulated in flight within the sensible atmosphere. Space vehicles of any kind that originate on earth must pass through the atmospheric envelope both on the outward and return journeys.

The NACA has much to offer as a national space agency outside the Defense Department.

First, its more than 40 years of experience and often proved capability cannot be ignored.

For example, most of the airfoils incorporated in the design of all aircraft are NACA developments or refinements. The high lift and relatively low speed airfoils that allowed the United States to become the undisputed world leader in air transport operations were NACA developments.

The laminar flow wing that made the P–51 Mustang the outstanding fighter of World War II must be credited to the NACA. Likewise, the efficiency of many of our current supersonic military aircraft can be attributed, to a large degree, to high speed aerodynamics research by that agency.

For example, the so-called "coke bottle" fuselages of the F–102, the B–58 and other supersonic military aircraft have greatly increased their maximum velocities. These shapes were designed in accordance with NACA-developed "area rule" theory.

Studies and experiments started by the NACA in 1952 have led to the X–15 aircraft which will let man go more than twice as fast and four times as high as he ever has before.

More recently, results obtained by this agency have helped solve the reentry problems for ballistic missile warheads. NACA research has helped prove the feasibility of the boost-glide aircraft—spacecraft hybrids that will be able to orbit the earth many times and reenter the atmosphere at will.

At the same time, this far-looking agency is accomplishing research and experimentation in new means of propulsion; ion, photon, nuclear, and solar, to name a few.

Many of the research facilities needed as basic tools for explorations of outer space are already at hand in the NACA. Facilities worth more than $300 million are now in everyday use. In that respect, the NACA has demonstrated a unique capability to devise, design, and construct new research tools. Their accomplishments in advanced wind-tunnel design is but one of the many examples I could point out.

The NACA employs more than 7,500 people, of whom more than 2,000 possess professional degrees. They are a competent, well-balanced team.

But, perhaps most important, the NACA has established a fine working relationship with the military services, the scientific fraternity, and industry. Its leaders are as respected as the scientific data that result from its research activities. General Doolittle, the Chairman, is an outstanding scientist, military and industrial leader. Dr. Dryden, the Director, is recognized as a practical scientist and effective administrator.

I cannot urge too strongly that the Congress act favorably on proper legislation that will redesignate the National Advisory Committee for Aeronautics as the National Aeronautics and Space Agency and change its mission and responsibilities accordingly.

And, now, let me turn briefly to my last area, a few of the tasks we must concentrate on to insure that the United States not become a second-rate world power in space capability.

Fortunately, we are in a relatively good position today because we can use the ballistic rocket as a basis for initial exploration of space. Recent events, the Russian sputniks and our own Explorers and Vanguard, have driven this fact home.

The ballistic missile programs have contributed in a very concrete sense from the standpoint of hardware that has or is being developed. A tremendous industrial capability and production capability is being built up in many new areas of technology. The airframe, propulsion, and guidance subsystems development and the data which is becoming available as test flights continue make possible a whole gamut of follow-on space projects.

We already are taking advantage of existing technology to prepare for scientific explorations of the moon, perhaps later this year. As you know, the ARPA recently directed both Air Force and Army research and development agencies to conduct a series of "moon shoots." The Thor and Jupiter missiles will be used as basic boosters, with other existing rockets added as additional stages, to send a payload to the vicinity of the moon.

Ballistic-missile technology is also being used as a basis for the military satellite now being built by the Lockheed Aircraft Corp. under Air Force contract.

But I promised earlier that I would not talk too much of hardware now under development; therefore, let me call your attention to two areas in which I feel that greatly increased endeavors are called for.

The first of these is basic and applied research in all of the sciences: Propulsion, materials, electronics, geophysics, biosciences, aero-astro mechanics, and others. That obviously is too broad a field for me to cover in one session; instead, let me use propulsion as an example.

Not only should we accelerate our efforts on the large liquid and solid propellant chemical rockets of the near future, but we must look considerably further ahead.

If we are to eventually conquer the giant distances of even our own solar system, entirely new propulsion systems probably will have to be developed. Spaceships might never be able to carry the enormous quantities of chemical fuel needed to travel freely throughout the solar system.

One new propulsive method undoubtedly will be nuclear, either a nuclear pile using heated fluids or nuclear fusion which can have unlimited range across the solar system. The next step might logically be ion propulsion; that is, obtaining thrust through ejection of a stream of ionized particles. These latter methods are under study now and, theoretically, can supply the propulsion means for extended space travel.

Also under consideration is photon propulsion. This method would propel spaceships by the actual pressure of light particles, but at an extremely slow rate of acceleration.

Those few examples of propulsion developments promise only relatively distant payoffs, timewise. But [that is typical of all basic research. We are proceeding today in astronautics developments on the foundation of technology started 10 or more years ago. If this country is to be the undisputed space technology leader 10 years from now, then we must put more effort into basic and applied research.

As a final item, I should like to touch upon piloted space vehicles.

This committee probably will hear some who cannot visualize the usefulness of manned space vehicles and who honestly believe the ballistic missile and unmanned satellite represent the ultimate in military weapons. I do not share that view.

I want to stress that I cannot conceive that mechanical gadgets alone will ever control space. Rather, man will develop the equipment, launch it, and bring it back. On many occasions, and probably more than we envision now, man will fly the equipment. My point is that man's judgment and unique reasoning ability will always be required to realize maximum effectiveness from any vehicle or weapon system.

Actually, man has already invaded space, at least his mind has, in the form of remote-reporting satellites. But the true conquest of space will come only when man himself flies well beyond the farthest reaches of the sensible atmosphere in vehicles of his own design.

For centuries, man threw or catapulted things through the air, rocks, spears, arrows, bullets, rockets, artillery shells, and other items. But it was not until 1903 when the Wright brothers made the first powered flight in heavier-than-air craft did man really begin to conquer the atmosphere. And then, prophets could not visualize military or commercial uses for the airplane!

Similarly, man will not conquer space until he penetrates it in manned vehicles whose flight paths he can plan and in which he can return at a time and to a place of his own choosing.

In the Air Force, progress toward space has been evolutionary, the natural development of speed, altitude, and sustained flight. These qualities have been our stock in trade throughout the 50 years of Air Force history. We have continually striven to fly faster, higher, and to remain airborne longer.

This evolutionary process which has brought the Air Force to its present high state of development does not change in direction because there are additional challenges in space. Aeronautics and astronautics are closely allied. In fact, astronautics is only a part of aeronautics.

Actually, the Air Force has been penetrating the fringes of space for several years in manned aircraft. Men like Yeager, Everest, Apt, and Kincheloe have been our pioneers in the famous X–1 and X–2 series of aircraft.

Much of the research which the Air Force has been conducting on the ground likewise is designed to place man in space. The Department of Space Medicine was established almost 10 years ago at Randolph Air Force Base, Tex. Physiological experimentation is also being conducted under the auspices of the Aeromedical Laboratory at Wright-Patterson Air Force Base. Volunteers like Colonel Stapp and Major Simons have opened the doors to much valuable knowledge concerned with placing man beyond the earth's atmosphere.

We will have our first quick look at piloted space flight next year when the X–15 begins its long series of tests. However, it should be emphasized that this is a flight into space rather than actual space flight. The pilot will be in space and weightless for several minutes, but it is too short a time to be called true space flight.

A proposed Air Force follow-on project is an extension of the X–15 concept. These are the Dyna-Soar boost-glide vehicles which will be lifted to global orbiting speeds and altitudes and reenter the atmosphere in a manner similar to the X–15. Although both of these vehicles are but one step away from true spacecraft, they still are hybrids, half airplane, half spacecraft.

Very likely, man will first realize true space flight in a manned satellite capsule of some kind. Under the guidance of the Advanced Research Projects Agency, the Air Force now is investigating several proposals for recoverable manned satellites. Manned space flight in this manner is much closer than you think, a certainty within a relatively short time. I believe we should push this project with all possible vigor and at the highest national priority.

In connection with these piloted space vehicles, you may notice that I have not mentioned any specific weapons that would be employed. In that respect, I should like to underscore a thought that appears to have been overlooked by some who question their usefulness. I don't know what kind of weapons man will use in these spacecraft, but I do feel reasonably sure that present-day concepts and weapons will not be married to space-type vehicles.

In fact, it is quite possible that the nuclear warheads of today will be totally obsolete. Undoubtedly, many new equipments and techniques will be developed in conjunction with the space vehicles. It is even possible that some fantastic new device might enable our manned space forces to neutralize or paralyze an aggressor without loss of life or destruction of property.

That seems a highly imaginary possibility now, so much so, in fact, that some knowledgeable individuals will flatly declare it impossible. I could only counsel against the negative approach lest we parallel the 1903 prophets who could see no military use for the airplane, or those in 1941 who refused to believe the power of the atom could be harnessed in a bomb.

America has progressed by following the positive approach to all challenges. It will continue to grow and prosper only if we adhere to that philosophy. We must believe that new scientific discoveries, if properly controlled, always prove of benefit to mankind. We further must accept that new discoveries only result from continuous and widespread exploration, much of which will be fruitless.

There has been exploration since the beginning of mankind, since the beginning of curiosity. Because of the airplane, there are very few secrets on earth with which we are not acquainted. Now, the ex-

ploration by mankind will continue, only in space as well as in other areas.

As a nation we must have both vision and tenacity to be the leader in this new type of exploration.

If we do not expend the thought, the effort, and the money required, then another and more progressive nation will. They will dominate space and they will dominate the world. We must not let it happen by default.

We in the United States can be first. However, to do so, we must not only expend much thought, great effort, and considerable money, but to borrow a thought from Dr. Killian's Space Primer, we must also be very bold in our execution.

Mr. Chairman, that concludes my statement.

The CHAIRMAN. General, I noticed on page 3 of the mimeographed statement you said:

> We in the military fervently hope that all nations join together in whatever measures need be taken to insure that space is never used for any but peaceful purposes

This is a new field that mankind is entering into. It might be termed the space age for descriptive purposes. Before any 1 or 2 countries make sharp advances, with the competitive situation that might develop, and before practical advances are made where they can be utilized for destructive purposes, we have to face the fact immediately in front of us, that now is the time to have the nations of the world enter into an agreement that might reasonably insure that the advances made will be used only for peaceful purposes.

General PUTT. Mr. Chairman, of course, in any situation of this nature where one is to sit around a conference table and work toward world peace, one must be careful in negotiations that we were in a proper position to insure that the results of such international agreements will go in a way that will best benefit mankind.

While I have not thought this through to its conclusions, it would seem to me that very careful thought would have to be given to the time when such advances might be made for an international conference and also as to where we, ourselves, stood at the particular time.

The question is a good point and it will take a lot of diplomacy and judgment to know when to proceed along such a course of action, but it would seem to me that however we might arrive at international agreements, that at least it is a good objective to be working toward.

The CHAIRMAN. Of course, my question was a very broad one and included the thoughts in my own mind and some of the thoughts you had. These do not involve the question of not proceeding because you could not stop that anyway.

General PUTT. That is right.

The CHAIRMAN. But the agreement for the uses. It seems that there might be a probability of greater success on the international level, if any can be obtained, before the fact rather than after the fact.

General PUTT. Yes.

Our thinking here was sort of a continuation of the efforts of our President to at least have greater cooperation among our friends and nations in scientific and technical fields, and it seemed to us there would be an advantage at the proper time, under proper circumstances, where space technology could be included in that kind of thinking

The CHAIRMAN. Your statement conveyed to me the fact that you

had it prominently in mind, otherwise you would not have included it in your statement. It was stressed so effectively that it conveyed to me that it was a mature thought on your part.

That is what caused me to make the inquiry, not that activities should not be undertaken by our own country but is there not a better possibility for discussion as to future uses for peace purposes before the fact than what might be termed after the fact?

General PUTT. That is correct.

The CHAIRMAN. Mr. Brooks, do you have any questions?

Mr. BROOKS. General, I think you always present the subject matter forcefully. You have done it in this case and with clarity too.

I want to ask you a few questions.

You end your statement with a paragraph which leaves no doubt in my mind that the nation which dominates space is going to dominate the world. That is true, is it not?

General PUTT. That is certainly the way I feel; yes, sir.

Mr. BROOKS. And we have no choice but to move forward in the development of space discoveries?

General PUTT. I can see no alternative.

Mr. BROOKS. If we do not, we can assume that Russia will move forward and preempt space ahead of us, in which case we may have no assurance that it will be peacefully used.

General PUTT. That is correct.

Mr. BROOKS. If we move forward and make the discoveries and make the developments, we can then control the use of space so that it will be peacefully used for the world, for this earth.

General PUTT. I certainly subscribe to that.

Mr. BROOKS. I want to get this straight in my mind. There is another thing that I would like to know.

How high do you, or does the Air Force, consider it is necessary to go in order to reach outer space? What is your definition of outer space now?

General PUTT. This is a relative question that is occupying the thoughts of a lot of scientific, as well as a lot of legal people, as to where the atmosphere ends and space starts.

One of the, in my mind, less accurate statements, is that the atmosphere extends out to that point where vehicles are airborne, but I am not so sure that that is a practical division.

As I said, in my statement, I do not think that there is a dividing line between aeronautics and astronautics, between the sensible atmosphere and space.

I might use the analogy of the sea. From the surface of the sea to the bottom of the ocean there is a great change in density.

From the bottom of the ocean to right on the surface, we never think of there being a layer of the sea that has something different about it than another layer of the sea.

Maybe, from the legal standpoint, this is pretty naive and something else has to be done. But from a scientific and technical standpoint, I do not feel that one can make a division between the atmosphere and space.

Certainly there are some new sciences and some new problems that enter as one goes farther into space, but we just consider it a normal extension into a visible area of operations.

Mr. Brooks. General, if you were going to just set an arbitrary limit to the inner space as contrasted to outer space, what would you say was an arbitrary limit dividing the two?

If the chairman has no objection, we shall be glad to have Dr. Dryden answer.

Dr. Dryden. I agree with what General Putt says, that the boundary between the atmosphere and space is entirely arbitrary.

You have an airplane weighing 20 pounds per square foot. Atmosphere is where that airplane can fly level. But you immediately have it fly higher when you have an airplane weighing 3 pounds per square foot.

Generally speaking, we say if we can get a body up above 200 miles there is very little influence, very small influence of the air on its motions.

So you might think that 200 miles is an arbitrary limit or if you like, you can come down to a very much lower value.

Now, this designation of inner and outer space has crept in. I confess I do not know what it means. At present we are thinking in terms of travel within the solar system, mainly because of the fact that the little extrapolation we do if we try to go outside the nearest star, which is 4 light years away, the same people could not come back.

Someone facetiously suggested you would have to send out a group of families and hope that the children would come back.

So normally we think of the reasonable space within the solar system.

Our immediate objectives are going out, of course, in the general neighborhood of the moon. Later on we hope to get out in the neighborhood of Mars and Venus.

But this is extrapolated on present experience so far. I don't know what to call inner and what to call outer.

Mr. Brooks. The reason I asked that question is because General Putt has referred to the fact that domination and control of space is control of the earth.

Then what do we mean by control of space there? If we are hazy as to the beginning of space there and we are bound to be hazy to some extent, just how far up do you mean?

Dr. Dryden. I do not want to differ with my distinguished colleague or some distinguished Senators. I think for the near future, the people who control sites on the ground are going to control the space they get into in the immediate future.

Only at some later date will it be appropriate to perhaps reverse this process. Actually, presumably we are interested in things on the earth anyway, and we are interested in space in the sense that you have been talking as a possible source of harm to us here on the ground.

Now, the further away the object is in space, the longer it takes to get to the earth and to the ground to do us harm. So in a way, you might say that space operations which are at the moment confined to the neighborhood of Mars are not putting any particular threat to us here on earth; whereas, the present ballistic missiles which go up just a short distance in space convey much more of a threat.

Mr. Brooks. Well, we will put it this way. General Putt said that the reconnaissance satellites could circle the earth and be a threat. Is that correct?

Dr. Dryden. A threat to your privacy.

Mr. BROOKS. Our privacy and consequently to the peace of the world.

Dr. DRYDEN. It is like people looking in your back doors and your factories.

Mr. BROOKS. How high would that be?

General PUTT. That would be in the order of 300 miles.

Mr. BROOKS. And then weather forecasts and weather control, you envisage the actual control of weather, do you?

General PUTT. We do not say that this can be done. It could turn out to be a possibility.

Mr. BROOKS. That would bring you up pretty high, would it not, above 60,000 feet, for that purpose?

General PUTT. That is true.

I might draw an answer, by analogy, to your question of how high one must go to control space. I think we can draw an analogy just from our aeronautical experience itself.

We have always strived to try to fly higher and higher. One could control the atmosphere by just being able to fly a little bit higher than the other fellow. So I think the same thing will occur in space.

It is always going to be a race who can get higher and farther out. So that control of space could start initially at a relatively short distance away from the surface of the earth.

Mr. BROOKS. That is more my thought. How low can you come in a space world and still dominate the earth? Radio and television would mean remote use of space areas, would it not?

General PUTT. I am sorry; I did not understand the question.

Mr. BROOKS. You referred to communications, radio and television, and to satellites providing communications. When you referred to the use of radio for that purpose, that would be for remote areas, would it not?

General PUTT. It would be for remote areas. Also, it would be a great aid to just global communications from point to point on the surface of the earth.

We are now limited by the natural phenomena, by the curvature of the earth, line-of-sight electrical horizon which prevents us from communicating directly from one point of the earth to the other where they are separated by great distances. By having satellites used as relay stations, one can communicate directly on a continuous basis.

Mr. BROOKS. In other words, send the wave up and let it bounce back.

General PUTT. That is correct. We could have television broadcasts direct from here to Europe, for instance, instead of being limited to just this line-of-sight distance.

Mr. BROOKS. Do you know what satellite it is going to bounce off when you send it up?

General PUTT. Surely.

Mr. BROOKS. I want to ask you about NACA. I helped to frame legislation organizing NACA.

Is it adaptable to the purposes which you have in mind?

General PUTT. Absolutely; in fact, I think it is really the best practical solution that we could find and I think they are eminently adaptable to the work in space because it is just an extension of the work that they have been doing for years.

Mr. BROOKS. Are the grades of scientists that we have in NACA comparable to any scientists in the world?

General PUTT. I think they are.

Mr. BROOKS. Do you have any particular criticism about the background and education of these men or their shortcomings?

General PUTT. No, I do not. Of course, you can always say, gentlemen, we wish we had better.

Mr. BROOKS. You would not be in the Air Force if you did not want something better, would you?

General PUTT. That is correct. We are never happy. We are never satisfied.

But I think, everything considered, that NACA has been eminently successful in organizing and acquiring a real outstanding team and group of scientific and technical people.

Mr. BROOKS. I think they could carry it on even in this era that you are looking forward to.

General PUTT. Yes, sir.

Mr. BROOKS. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. General, in your statement you stress the importance of controlling space in order to preserve our way of life, and you further point out the fact that if this country is to be the undisputed leader 10 years from now, we must put more effort into basic and applied research.

General, I certainly agree with those statements. How do you feel about a crash program?

General PUTT. Frankly, I think that unless circumstances dictate that one's only alternative is to go into a crash program, that they are not the way to do the job.

It takes more money; it takes more people; it takes more in the way of facilities to insure a successful crash program.

You have to cover your bets in many ways and you have duplication that otherwise would not have to be engaged in if one proceeds on a leisurely, an orderly, and vigorous program which is sustained and constant and meets the needs.

I think crash programs are wasteful. We get ourselves into situations where sometimes this becomes absolutely necessary, but I do not think it is the way to run any kind of program and particularly a scientific program.

Mr. NATCHER. General, would you agree that at least we should step up our present program from the standpoint of more appropriations for those programs that we are sure about at the present time?

General PUTT. I do.

Mr. NATCHER. General, why not just meet this problem head on and just face the facts. You agree that the Manhattan project was a success and necessary at the time. We now know what to expect to a certain extent as far as outer space control is concerned.

Why not just meet the problem now and move on? Do you feel, General, that we are proceeding fast enough at the present time?

General PUTT. I would like to see us proceeding somewhat faster than we are. I think we should do this with good judgment and be sure that we are on the right track.

One of the real difficult problems that I think faces all of us in the management and administration of our space technology programs

is that suddenly with the advent of large rocket motors that make it possible to get out into space, we have opened up such a broad vista of things that could be done, that the real management job now is that of exercising good judgment in selection and doing the things that are proper and not just scatter our shots all over the place.

We could spend billions of dollars on interesting projects. We could disperse our effort.

I think to get on and to make the most of the resources and people that we have, we must be very selective and do the important things and do them first.

Mr. NATCHER. General, the people in this country, I feel, have gotten a little complacent since Explorer No. 3 has been placed in orbit. Do you agree that the day for this type of complacency has passed?

General PUTT. It certainly has, long passed.

Mr. NATCHER. General, how do you feel about science receiving a position in the Cabinet?

General PUTT. Well, I am afraid I have not given enough thought to the exact manner in which this country should organize to give due account to the contributions that science has made, or will, of necessity, make in the future.

But I do feel that some greater emphasis, some greater cognizance of the tremendous role that science is going to play in the future, science and technology, in the future advancement and development of our country, certainly wants some steps other than we have taken in the past.

Mr. NATCHER. General, I want to ask you just one particular question, which is technical insofar as I personally am concerned.

How close to the earth can a satellite be put into orbit?

General PUTT. I think one can put a satellite into orbit at about 100 miles, something of that order.

However, the duration, the time that it will stay in orbit, decreases as one gets closer to the earth's atmosphere where you have the atmospheric drag to slow it down.

It has to maintain its speed to maintain a given distance from the earth.

Mr. NATCHER. Thank you, General.

I want to thank you further for the fine statement you have made to this committee.

General PUTT. Thank you.

The CHAIRMAN. Mr. Metcalf.

Mr. METCALF. General, Mr. Brooks raised a question in my mind. Suppose some foreign government sent a low-flying reconnaissance plane over the United States to map the various areas of our country. What would the Air Force do about it?

General PUTT. How low is low in your mind?

Mr. METCALF. Say 2,000 feet.

General PUTT. We would shoot him down.

Mr. METCALF. Suppose they send a satellite with television cameras over the same area, mapping, reconnoitering, and sending information back to that same foreign government, what does the Air Force propose to do about it?

General PUTT. At satellite altitude, sir?

Mr. METCALF. Yes.

General PUTT. There is not much we can do right now.

Mr. METCALF. The question is whether you cannot do anything, or you are not going to do anything. You do not believe there is authority to do anything?

General PUTT. We would if we could, and we think there are some things that can be done if we get along with it.

Mr. METCALF. Then does that not bring up right now the necessity to have some international agreements as to what we are going to do with these satellites in order to carry out your proposal that we join together for peaceful purposes for the use of space?

General PUTT. That certainly could be one approach to the problem.

Mr. METCALF. Because, at this time, the air forces of other governments are unable to do anything about this reconnaissance of their country by means of satellites in orbit?

General PUTT. That is right.

It seems to me that at the present time international agreements are the only way that one can control the use of satellites.

Mr. METCALF. Then actually, the question of where space begins and where it ends is a question of whether the Air Force can shoot down a reconnaissance plane?

General PUTT. That might be one way of defining it.

Mr. METCALF. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Arends?

Mr. ARENDS. First, may I say I am pleased to see you here before the committee. I had the pleasure of listening to you on several occasions on the Armed Services Committee when you brought your presentation before that committee.

I note here this morning that you are appearing still as a Deputy Chief of Staff for Development within the Air Force.

General PUTT. That is correct.

Mr. ARENDS. Somewhere along the line I saw a note you were going to retire someplace, I am sorry to say, because I recognize in you a man of ability and I was hoping you could remain on the job.

Let me ask you this very simple question which was prompted by the gentleman from Montana a moment ago, as to the impossibility of doing anything should the satellite be rushing over the United States for a purpose that we could not do anything about. I think the other side of the coin is the fact that while they are doing that, we likewise would be doing something.

General PUTT. That is correct.

Mr. ARENDS. So I think we must not let ourselves get into a position of defeatism. There must be recognition of the capabilities we have to do the job in the event somebody tries to do that kind of job to us.

General PUTT. That is correct. The major countermeasure race always goes on in almost any new field of endeavor.

I can assure you that we have been doing a lot of thinking about the antisatellite satellite.

Mr. ARENDS. Because I know what you have in mind and what you are able to do might I just ask this question merely as a matter to put into the record again: Whether we are moving fast enough, whether there is something more that Congress in its responsibility should do to expedite a program one way or another, whether it is money, whether we are hamstringting you, your department, in any way in moving ahead as expeditiously as maybe you feel you should?

General PUTT. Of course, there are a lot of factors that have to be taken into account, our entire economy and the other responsibilities of the Nation.

Purely from a technical and scientific standpoint, I think there are things that could be done, a greater emphasis, requiring more money, more facilities.

There is a question of balance between what we can afford to do there and what we can afford to do in the other necessary areas.

But purely from the technical standpoint I think there are things and areas in which we could move a little faster. Whether this is true in the overall, the people have to make the decisions at the highest level.

Whether this is a proper balance, I am not in a position to say.

Mr. ARENDS. That, General, is very important. In all these matters such as this, there must be balance and that is where our responsibility comes in, to see that there is balance. This balance must be maintained.

I think you recognize now, and I hope you do, and the country recognizes, that there is an awareness on the part of Congress and you people that have responsibility in moving ahead on the program, that there is awareness to move as fast as we can, doing the kind of job that is well done when we finish.

General PUTT. That is correct.

Mr. ARENDS. Thank you.

The CHAIRMAN. Mr McDonough.

Mr. MCDONOUGH. General Putt, I was interested in your modest attempt to define outer space and the question of dominating that area by one nation or another. Can we not assume at the present time, with the United States not contesting Russia when they send up a satellite into outer space, it flew over the United States the same as it did the other countries, and Russia not contesting the United States when we put up a satellite, that there is up to the present time without any international agreement a common agreement that outer space is like the open seas, a highway for all nations to use?

Then can we not assume that if the question of domination is brought into the picture at the present time, we are dominating outer space because we have three satellites in orbit and they have none at the present time.

In other words, to establish ourselves in outer space like we might have established ourselves in discovering a new country, you have to go there and occupy it and be there on the ground and fight off anyone that may contest your position.

So that we are in a more favorable position right now with three satellites up than Russia is.

Of course, this committee will undoubtedly go into the question of what is our legal status and at what elevation, as far as the United States is concerned, and that puts a question in my mind. In the revolutions of the earth we cannot stay in one position because we are moving at the time, therefore how are we going to take a band of area around the atmosphere, say it is legal territory around the United States, and say that the enemy cannot come in.

I suppose that the question of establishing our legal right in international agreement is something that is more or less up to—I do not know what agency of the Government, the State Department, or who would decide the question, but it is one that we will have to consider.

Now, insofar as the environment in which man can live and in which the vehicle that he operates can live, is that not a reasonable limit for inner space?

General PUTT. From a technical standpoint it seems to me that if we can provide the environment for the man to live at, say, a hundred, or 200 miles above the earth, at the moment I do not see that it is much more difficult for him to carry that environment still higher.

Certainly you will run into problems when one gets close to the sun, but in normal space I think one could operate.

If you can operate at 100 or 200 miles, you can operate at a thousnad miles, for instance.

Mr. MCDONOUGH. Did we learn anything from Farside except the fact that we shot a rocket to a high elevation? Did we obtain any information from that outside of the fact that we shot it up to a high elevation?

General PUTT. Yes. I think one acquires more information as one goes higher, but as the elements change, we learn something about the temperatures that prevailed at different altitudes. It is not a continuous or constant temperature.

Cosmic rays vary. So that the higher we go, the farther out we go, we find new information and knowledge.

Mr. MCDONOUGH. Farside has gone to a higher elevation than any of our satellites?

General PUTT. Yes, it has.

Mr. MCDONOUGH. It is estimated at 6,000 miles; is that correct?

General PUTT. No, I think our final figures were 2,800.

Mr. MCDONOUGH. There were attempts also to shoot small pellets to the moon. Did we ever find out whether we hit it, or not?

General PUTT. I don't think we know.

Mr. MCDONOUGH. You say the flight of the X–15 would not be a space flight, it would be merely to penetrate space.

Is not the X–15 equipped to fly in outer space?

Dr. DRYDEN. Mr. Chairman, it would be something like a fish jumping out of water. It has a rocket motor which will propel it to high altitudes, to positions where it cannot fly in the normal sense, because there is no air. It will then fall back to an elevation where there is enough air to support it.

So the space flight of the X–15 will be this type of thing like a fish jumping out of water into the air and coming back in again.

Mr. MCDONOUGH. In other words, we are not building a space flight ship.

Dr. DRYDEN. The X–15 was built as a research airplane to study the problems that you have in space flight.

For example, to control the attitude. If you just let the airplane come out and fall back, you get into great trouble. You must turn it over so that it comes back in a normal fashion.

This requires the use of rocket-type controls. We are at present flying such controls on one of the X–1 airplanes to work out some of the problems before we fly the X–15.

The same way in heating. As you probably know there is no trick to put a man in space. Anybody who will take the place of the nose cone on one of the missiles fired at Canaveral will be ejected into space. This is a relative part of the problem.

The X–15 is studying this problem of getting back without burning that airplane up.

Mr. McDONOUGH. Why is an 18,000-mile speed the established speed for a satellite to get into orbit?

Dr. DRYDEN. A satellite is in the position of falling all the time, but just enough to keep up with the curvature of the surface of the earth.

Now, the speed that you have to go so that it only falls at the rate dictated by the curvature of the earth is roughly 18,000 miles an hour. You cannot fly a satellite at any other speed.

If the speed is higher, it will go out into an elliptical orbit. The higher the speed, the greater the elliptical orbit. The slower the speed, it comes into the atmosphere.

General PUTT. Mr. McDonough, the X–15 is a joint Navy-Air Force-NACA project. NACA has the technical direction of the project.

With Dr. Dryden here, I thought it more appropriate that he answer that question.

Mr. McDONOUGH. I appreciate that.

What is the next step beyond the X–15 and is it under consideration at the present time?

General PUTT. In terms of manned vehicles, it is the Dyna-Soar. This is a hybrid aircraft that will operate in space and will also handle and operate very much like a conventional airplane within the atmosphere. It will attain almost satellite speeds.

It combines the dynamic forces of its speed while circling the earth along with a form of soaring. That is where it gets its name of Dyna-Soar, a combination of the dynamic forces and soaring flight.

In effect, it comes back into the atmosphere a little like a glider, except that it has some power.

Mr. McDONOUGH. At what stage is that in or is that classified?

General PUTT. Let us just say it is under development.

Mr. McDONOUGH. As far as the X–15 is concerned, there is only one that we are building at the present time?

General PUTT. There are three actual articles to be used in the complete test program.

Mr. McDONOUGH. They are three different types of ships?

General PUTT. They are all the same. We find that it is real good to have more than one airplane in any kind of a test program because if something happens to one, then you have to go back and start over again and you lose a lot of time.

Mr. McDONOUGH. When Dr. von Braun was before the committee yesterday he said he was prepared, and he could within a year, build a Redstone and provide a man-contained capsule in the nose and shoot him to the moon, but he was not authorized to proceed.

General PUTT. Not to the moon.

Mr. McDONOUGH. I mean into outer space and to return.

General PUTT. It was just a ballistic ride, tossing him out and coming back. In a sense it is the same thing as the X15, although it probably would go higher and the man, I guess, will be in space just about as long.

Mr. McDONOUGH. If he had the equipment on board to observe and to record some of the conditions up there he would go higher than the X–15 and, therefore, give us more information. But he said he was not authorized to proceed.

Do you know why he was not authorized to proceed?

General PUTT. No, I do not. The Air Force, likewise, has a program somewhat similar to that, a little different in scope.

Dr. DRYDEN. May I step in where angels fear to tread?

I feel there are something like 200 projects to put a man in space originating with various groups in the United States. They range all the way from tossing a man up in the air and letting him come back—which, to my mind, is about the same technical value as the circus stunt of shooting the young lady from the gun—to projects where he remains in the satellite for several orbits.

Now, the great problem of the people concerned with this, and I am glad that I do not at present, at least, have the responsibility, is to pick which ones of these 200 projects is to be supported.

That is all.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. We are glad to have you here, General. I am sorry to know that you are retiring. Are you not under age for retirement?

General PUTT. I believe not. From the standpoint of compulsory retirement for age, you are correct. However, I have completed 30 years of service.

Mr. FULTON. There is some good yet and why do you not stay in? Are you leaving because of any possible holdback by the Air Force on any of your ideas and you might get a broader field outside to express them?

General PUTT. Absolutely not. I am not retiring because I am angry with anyone or in protest of anything.

Mr. FULTON. But looking for a broader field? I did not put the word "angry" into that.

General PUTT. Not necessarily looking for a broader field. I do not know of any particular industry, or position that one might hold, that gives one the opportunity to look as broadly as does the position I hold in the Air Force.

Mr. FULTON. I believe the Congress has the policy of trying to encourage the young fellows with ability to remain with the Air Force.

General PUTT. That might be an element in my retiring so that the youngsters can take over.

Mr. FULTON. We think you are young enough and competent enough so that we would like you to stay.

Let us go further. The problem comes up with the development of the million-pound-thrust engine. Are you familiar with that and the effort to try to obtain a million-pound-thrust engine in the near future?

General PUTT. Yes, sir.

Mr. FULTON. You also know that to date, on studies, the amount spent has been about a half million dollars. Is that not right?

General PUTT. That is approximately correct.

Mr. FULTON. What would your estimate be of the total cost of getting a 1-million-pound engine, something between $40 million and $200 million?

General PUTT. Let me check our records here to see what it is.

Mr. FULTON. I am only a Naval Reserve officer. What is your estimate in general figures, round terms? Is that the area of magnitude that you would likewise estimate?

General PUTT. It is probably in the order of two hundred and fifty to four hundred or five hundred million dollars.

Mr. FULTON. So that it is between two hundred and fifty and five hundred million dollars to make the program. Then under your estimates, at the present rate of expenditure and study by ARPA, it would take between five hundred and a thousand years?

General PUTT. If we maintain the constant rate.

Mr. FULTON. Then what do you suggest? Do you not suggest a tremendously increased program, as I do, which would be somewhat in the nature of a crash program, so that we get there before Russia does?

General PUTT. Certainly we would not recommend retaining the present pace. All research and development projects start out at a relatively low level and, if they proceed normally, the rates of expenditure go up quite rapidly.

Mr. FULTON. In order to have a million-pound-thrust engine developed in 3 years at your lowest estimate of $250 million, we would have to start out with fifty to sixty to seventy million dollars a year in the program right away, would we not?

General PUTT. That is too much for the first year.

Mr. FULTON. We would have to take a tremendous step forward above $500,000, would we not?

General PUTT. Yes.

Mr. FULTON. So it would be up to fifteen, twenty, thirty million dollars for the single project of a million-pound-thrust engine?

General PUTT. That is right.

Mr. FULTON. On the electronics signaling devices that you speak of, by electronic bounce we could monitor and keep under surveillance every part of the world, could we not?

General PUTT. That is right.

Mr. FULTON. So that within a few months, if we would get satellites into space or even use the satellites that are already there, we could do some pretty good work on seeing just where the military buildup might be anywhere in the world.

General PUTT. We could not use the ones we have there now, but we could put others up to do the pioneering work.

Mr. FULTON. And we are able to get bounce off the moon; are we not?

General PUTT. Yes.

Mr. FULTON. So that actually, without any earthmade satellites at all, if we put the pressure on and make investigations we could certainly come up with a comprehensive monitoring system to assure United States security at the time?

General PUTT. Bouncing signals off the moon would not give us reconnaissance.

Mr. FULTON. Is there not some difference of opinion in the forces that it can be done?

General PUTT. None that I know of.

Mr. FULTON. Let us move into this photon vehicle. Do you think that a photon-powered vehicle is in the realm of practicality at any time, or within the foreseeable future?

General PUTT. I would not at this time say that it was within the realm of practicality.

Mr. FULTON. Dr. Merkle yesterday, when I asked the question, dismissed it as something that there should not be studies on and I notice in your statement this morning you are making studies on it. Why do you disagree?

General PUTT. I was not aware of his feelings on this. I hold the view that if there is any possibility of an idea working, one at least must explore it to the extent to insure that either it has or it has not got any promise.

So if there is a body of scientific thought that feels that there is some promise there, I think we ought to pursue it to the point where we determine there is or there is not.

Mr. FULTON. So you would recommend a testing mission really, to see if there is any practical basis and have basic scientific research on photons?

General PUTT. There is a lot that has to be done, and can be done, before one really starts testing. There is a lot of theoretical work that has to be done.

At that stage it is sometimes possible to determine whether it is worthwhile to go on, or not.

Mr. FULTON. But you are not leaving out of consideration of any military or weapons-vehicle program a basic research program on photon-powered vehicles at the present time?

General PUTT. It certainly is in the basic research stage. We certainly would not even be thinking of a military-weapons system that was so propelled at this point.

Mr. FULTON. But you would continue such studies, would you not?

General PUTT. If the basic research indicated it was going to be something that might be feasible and practical, why, then, we would want to at least study the possibility of its application to a military weapon.

Mr. FULTON. I am a member of the House Foreign Affairs Committee, so your comments on the freedom of space interested me. If we put it in its historical background we come to the statements by Grotius, that it was a Mare Liberum, freedom of the sea.

Then we have John Selden, an Englishman who, in 1635, came up with a book "The Dominion of the Seas." That was the beginning or the crystallization of British policy for quite a number of years.

Now, that brings you to a logical dilemma. When you speak of the freedom of space, are you a follower of Grotius, or are you a follower of John Selden, who held that the British Navy should have dominion of the seas for the benefit of nations of like mind and their allies?

Are you saying to us here on this committee that we should have the conquest of space in order to obtain dominion of space, having the power to control it by the United States and its allies, to the exclusion of another power or group of powers?

You see, it brings you to the historic perspective that you must decide whether we will again repeat history in space.

Are we really talking of the freedom of the seas? I can give you one more comment.

We tried in the United States to get away from that sort of dilemma in 1899 with other nations when we were participants in the first Hague Conference. We then tried again in 1907 to expand it without too much success.

The question is: Shall we proceed on the order of a Hague Conference and possibly suggest to the President of the United States that at the Summit Conference he take up with Russia and our NATO allies, the setting up of a Hague-type conference to deal with outer space so that we would have a space assembly similar to the kind that we tried to develop before World War I?

Actually, at the second Hague Conference it was Russia that issued the invitation and we accepted it.

So there is a historic parallel there.

As you may remember, too, there might be set up a commission of inquiry as there was under the Hague Conference of 1907, that we in outer space could have an inquiring commission that made no decisions, that met together on these knotty problems that might involve serious disputes.

Now, which one of these three courses should we take? Do you think we should take Grotius' approach that it is free to everybody, and as Mr. McDonough of California suggested, nobody make any complaints, just leave it open until something happens?

Another one is the theory of John Selden, of Britain, that we in the United States have dominion of space as far out as we can get it and then get into a race for space.

Or, thirdly, do you want it on the order of the United States calling a space conference similar to the Hague-type convention?

Your statement is not clear on the first two, and I am suggesting the third one to you for your consideration.

General PUTT. Mr. Fulton, I am not enough of a student of history in this regard to, I think, answer your question very well.

Mr. FULTON. May I ask it simply, then?

Do you agree that there should be freedom of space with everybody and every nation doing what they want until somebody tries to stop them, just leave it open? Do you agree with that?

General PUTT. I can only draw from my own experience in answering that.

We have seen the type of the freedom of the seas we now have. We have seen how it operates.

Mr. FULTON. Our Nation and the British nation cover 90 percent of the oceans and seas and control them. Is that what you want?

Mr. MCDONOUGH. That we have use of.

Mr. FULTON. That we have dominion of.

General PUTT. I would not think that we have dominion of it. We have the capability or we hope we have the capability of controlling the seas in the event somebody attempts to do something that we do not like. It seemed to me that maybe there is something wrong with the direct application of the analogy, but it would seem to me that what I am thinking of is something in the order of that as far as space is concerned.

Mr. FULTON. So you would favor John Selden on the power to control and obtain dominion, if necessary?

The CHAIRMAN. I do not think he said he would favor anybody.

Why do we not have your theory, then we would have the Fulton program, too?

General PUTT. This is really getting way out of my area of competence.

Mr. FULTON. All right. I recommend to the President that he take up at the Summit Conference and propose a third-type Hague Conference for dealing with the problems of outer space, and also request that a commission of inquiry be set up to handle these problems that may come up, without the power of decision, but with the power to inquire internationally to prevent disputes coming up.

Mr. MCDONOUGH. Will you yield at that point?

Mr. FULTON. I am through.

Mr. MCDONOUGH. Nobody has raised the question internationally up to now.

The CHAIRMAN. Well, I did slightly, there. I assure you I had it in mind, but go ahead.

Mr. MCDONOUGH. Since it has not become an international question and both Russia and the United States have used the space we are talking about, both nations, no other nations have gotten up there yet, the problem now is, I would say, that we ought to let sleeping dogs lie until somebody makes the point.

Mr. FULTON. May I make a short comment here?

There is a fine presentment. Here is the Grotius theory; the Selden theory with the General, and Hague conference with Fulton. We all disagree. What does the chairman say?

The CHAIRMAN. Might I suggest, and it is the first time that the Chair has undertaken to make a suggestion to the members, that we ask questions of the witnesses. Sometimes a little outer space might be necessary in connection with the question, but confine the questions to the witnesses, the questions that interest the different members.

I am going to read Grotius. I will put my mind way out in the dim past so as to familiarize myself with it.

Mr. MCDONOUGH. To expound on what you have just said, we cannot expect the Deputy Chief of the Air Force to come here as a legal space lawyer, an expert on such laws.

The CHAIRMAN. I would not say he was not qualified, but he would probably hesitate to enter into that field.

Mr. FULTON. Might I suggest that when the good General suggests that we dominate and get into a race for space as far out as you can get in order to fight the next war there with some sort of military weaponry, maybe some of us on the Foreign Affairs Committee want to know what kind of legal vehicle you are drawing.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. General Putt, I would like to pursue for a moment your observation on page 7, and elsewhere in your statement, where you said in substance that there was no essential difference between aeronautics and astronautics, or between outer space and inner space.

That is perhaps an oversimplification, but that is the impression I gained. Is it not a fact that the physical properties and elements of what is generally called outer space are completely different from the atmosphere of the earth?

In other words, what I am getting at is that there is no oxygen out there, is there?

General PUTT. That is correct. The problem here is one of change. You start at the surface of the earth. There is a lot of oxygen and atmospheric pressure.

As you keep going out it becomes less and less and less. In the same way the other gaseous elements of the atmosphere change. Their pressures change and the relative quantities, I presume, change.

Many of the techniques, the sciences, the theories that are required are merely extensions.

Mr. KEATING. For instance, specifically, we have craft that go through the atmosphere, what we call air-breathing equipment. Now, that is not suitable for use in outer space, is it?

General PUTT. That is correct, so far as propulsion is concerned. When we get out to the point where there is insufficient oxygen in the air to support combustion, then we must carry our oxygen along in order to create propulsion or a driving thrust.

That is what we do with the rocket. We carry the oxygen with us so that it can operate outside of the earth's atmosphere.

Mr. KEATING. You drew the parallel of the air being somewhat like the sea where there was a greater density or less density at different depths. As it has impressed me, and I certainly have an open mind on these problems, it is more a distinction between land and sea when you get into true outer space as against the atmosphere, in that the two are entirely different, not in degree, but in kind.

Now, you do not share that?

General PUTT. No, I believe not. I would agree that there is quite a difference between the land and space, but in my belief space in its broader sense starts just as soon as you leave the surface of the earth.

Surely there are different properties, different values of pressure, temperature, density, but it is a continuous variation of these properties and it is not just something that has suddenly become entirely different.

Ever since we have started to fly we have attempted to go higher, faster, and farther and we have gone through tremendous changes of pressure when you just go from the surface of the earth to 100,000 feet.

For instance, I think it is 99 percent of the earth's atmosphere which is below 20 miles altitude. When operating now at around 100,000 feet, many of the changes will be of a lesser degree from there on out than some of the things we have already gone through.

There will be different elements, different problems, but we think much of the theory, many of the techniques and propulsion systems, that have applied to aeronautics, guidance, probes, extend right on up.

The CHAIRMAN. Mr. Keating, might I interrupt at this moment. I have to go to the floor. Mr. Brooks will take over.

Dr. Dryden, you are available at any time, are you not, sir?

Dr. DRYDEN. Yes.

The CHAIRMAN. There is a bill up this afternoon. I think the committee would be under extreme pressure if they were to meet and could not explore as fully as they want to, so you will be available at any time they want you? You are here in Washington?

Dr. DRYDEN. Yes.

The CHAIRMAN. I hope you gentlemen will be able to conclude with the general.

But you understand, Doctor, we have no meeting this afternoon. You are available at any time at the convenience of the committee?

Dr. DRYDEN. Yes.

The CHAIRMAN. Thank you.

Mr. Brooks, will you take over?

Mr. KEATING. General Putt, there is much of the equipment and techniques which would be applicable to aeronautics which would not be applicable to astronautics also?

General PUTT. That is correct. There are new problems that will arise that we have not had to date. They become additive to the problems we have had in aeronautics.

Mr. KEATING. Do you not feel that there should be a complete redefinition of the missions of the three services, if for no other reason than because none of them now covers—and if you take issue with this, of course, you are free to do so—because none of them now covers outer space which could conceivably be tomorrow's principal battlefield.

General PUTT. Certainly, technology has provided weapons that cross present lines of service reponsibilities.

Likewise, it is questionable as to whether future wars will follow the classical lines of land, sea, and air.

If seems as though it would be probable that any given operation is a combination of all three types of warfare. I believe I would agree that we certainly must examine this and make sure that we are not following too much tradition and being unrealistic as to what kind of wars are going to be fought in the future with what kind of weapons. We might find ourselves not properly organized to carry out effective campaigns.

Mr. KEATING. In other words, our present missions are stated primarily in terms of land, sea, and air?

General PUTT. That is correct.

Mr. KEATING. And this concept, including the concept of outer space, calls for at least a reexamination of the definition of the missions of our three services?

General PUTT. I think that is correct.

Mr. KEATING. I was very much pleased to see the statement on page 3 of your fine presentation:

> We in the military fervently hope that all nations join together in whatever measures need be taken to insure that space is never used for any but peaceful purposes.

Resolutions we have introduced declare such to be the sense of Congress.

Now, do you think that the adoption by Congress of that principle—although the sense of congressional resolutions has no legal effect, it is often said—would have far-reaching effects among other nations in promulgating that idea among the peoples of the world?

General PUTT. I would certainly think so.

It seems to me that the United States, by whatever means is considered appropriate, should declare its intention and its feelings that space should be used for peaceful purposes.

Mr. KEATING. Thank you.

That is all, Mr. Chairman.

Mr. BROOKS (presiding). Mr. Ford?

Mr. FORD. General Putt, I have been impressed with your comments concerning the Department of Defense and primarily the Air Force working arrangements with the NACA and your tribute to the various programs that NACA has made possible.

Could you explain for the benefit of the committee what your past relationships have been with NACA? How does the Department of the Air Force, your office, work with NACA today?

General PUTT. First, there is a clear understanding between the individual services and the Department of Defense as to just the responsibilities and functions of the NACA as they pertain to research in aeronautics.

We look to the NACA for much of our basic research and fundamental knowledge that is applied by industry and the services in the actual development and design and production of weapons systems

Now, because of the facilities, the competence of the NACA in addition to their national responsibility for fundamental research in aeronautics, they on our request also undertake programs to assist the military and industry in the actual development of military weapons systems.

Mr. FORD Does the Air Force initiate these programs, or does NACA initiate such programs?

General PUTT. It works in this manner. The Air Force, for instance, would initiate a program for a new bombardment aircraft, let us say. We have to work out a considerable testing program, which includes the wind-tunnel testing of models.

We get together with the NACA and jointly work out testing programs where their facilities are most adaptable and their capabilities will get the job done the quickest and the best.

Industry itself has some of its own wind tunnels and there are other nonprofit organizations that operate wind tunnels and the Air Force and the Navy have some of their own.

These are all considered in toto. It is the question of the carpenter using the right tool for the right purpose.

Mr. FORD. As far as the military is concerned, somebody else comes up with a weapon requirement. From that point on, either through industry or through NACA, the research and development is carried on?

General PUTT. That is correct.

There is a standardized procedure whereby we make requests on NACA to carry out programs. These are all coordinated with NACA before a piece of paperwork goes through, to make sure, 1, that they accept it; 2, that it fits into the schedule, and 3, that the priorities are all in order.

The large part of the good relationship that exists between the Department of Defense, the services, and the NACA, is their system of subcommittees and panels on which there are members of industry and science and military representatives from the appropriate research and development activities and fields of operation.

Mr. FORD. I raise this question because, as you undoubtedly know, one of the proposals in the legislation is that there should be this committee of 17, including 8 from the various departments in the Government and 9 from without. One of the representatives from the Government would be somebody from the Department of Defense.

Now, do you feel that 1 out of 17 on such a board is adequate to represent the views of the Department of Defense?

General PUTT. I personally would prefer to see something different than the way it is stated. I do not believe the legislation precludes more than the one from the Department of Defense. It is my own feeling, and I believe it is that of the Air Force, that we would prefer to see the legislation specifically spell out 1 from the Department of Defense and 1 from each of the services.

Mr. FORD. That was the point I was getting to. Should we make it as it is here, which is just one mandatorily with the possibility of more, or should this committee recommend to the House that we should specify, such as you have suggested as 1 alternative, somebody from the Department of Defense and possibly 1 from each of the 3 services?

General PUTT. I think this is something that your committee should give real thought to, because I visualize a new agency being just as important to the military as has been NACA in the field of aeronautics.

It would seem to me that this has been so successful and the relationship is so important to our national progress in aeronautics and space, that we should try to retain the same general pattern.

It seems to me that the best interest of the Nation and the services and the space agency would be best served if we could specifically have Department of Defense, Navy, and Air representation.

Mr. FORD. Would you think it wise to pin down that the representation from each of the 3 services should be military or leave it flexible enough so that it would be a person from each of the 3 services, either military or civilian?

General PUTT. I believe I would make it military. I would hate to see a specific individual by office named. I can see some difficulties there, but I believe that I would prefer to see a military man because there will be civilian, scientific and technical people on the membership of the board from other organizations and activities and one, it seems to me, wants to get a sprinkling of military thinking because there will be plenty of scientific and technical competence within the board from other sources.

Mr. FORD. I am not personally familiar with the details of the relationship of AEC with the Department of Defense and the respective services, but it is my impression that there is one active military person who is attached to or serves with AEC, but he is bolstered up, so to speak, by a military liaison committee.

Would such an arrangement as that be adequate or would you prefer the suggestion that you made a few minutes ago?

General PUTT. I suppose another arrangement could be worked out, something along the line of the AEC. I do not know what Dr. Dryden thinks about this, but I think the relationship and the procedures for liaison and mutual support have been so successful in the past that it seems to me that rather than upset a system that is working so successfully now, that we ought to maintain that same pattern unless there is something I do not see that is new as we broaden NACA's activities into space.

I think we will get on with the job faster and with greater understanding if we can maintain the same pattern.

Mr. FORD. Would you like to comment, Dr. Dryden?

Dr. DRYDEN. Yes, I would like to mention a reason for the bill being written the way it is.

If you start spelling out the Government membership, I do not believe that you will be able to stop with the military. I think the AEC should certainly be represented, the Science Foundation involved.

I think once you start spelling them out you will have to spell them all out.

In the past we have had the situation where the particular membership was spelled out and then the legislation is changed and there is some other agency, then you have to come back and change the legislation to match.

So I believe the purpose of this is not to keep out any representation from any particular department or service, but to leave it flexible so that you would not have to amend this as soon as you gentlemen get through with the military reorganization bill, for example.

This possibility exists, of course, when you spell out particular individuals. The statutes change and you have to amend the legislation.

Mr. FORD. Does NACA now do work for all three services?

Dr. DRYDEN. Yes.

Mr. FORD. More or less along the same pattern with each?

Dr. DRYDEN. Yes. Up until the present time the Army has not been represented. There is a bill which has passed the House and is now on the floor of the Senate, which is quite obsolete now, of course, if you consider this legislation, but that did provide for 2 members from the Army just as they are 2 from the Navy and 2 from the Air Force on the present committee.

Mr. BROOKS. Mr. Ford, Mr. Feldman wants to ask a question right there.

Mr. FELDMAN. Dr. Dryden. Don't you think that the AEC has operated fairly well with the military and that that is written into the law?

Dr. DRYDEN. I did not make a comment on this suggestion. I think this is a way of bringing men in uniform into the picture. Presently, they are brought into membership on the Board, the Advisory Committee. They have liaison officers stationed at major laboratories. The Navy does it by traveling liaison.

Mr. FELDMAN. Don't you think it should be spelled out in the law?

Dr. DRYDEN. I think the military part of the agreement should be available and represented in some form. I think I would defer to you as to how it is finally left.

Mr. FELDMAN. Should this not be spelled out because the person in charge of, say, the new NASA, might be changed and have a different philosophy? He might, at his whim, decide that he does not need a military man.

Dr. DRYDEN. At present it is left in the hands of the President to nominate the Government agencies. That is the way the language is written now.

Mr. FELDMAN. You would have no objection to its being spelled out?

Dr. DRYDEN. I personally have no objection.

Mr. FELDMAN. Thank you.

Mr. BROOKS. Mr. Ford.

Mr. FORD. One general question, General Putt. From time to time there are some intimations that we have inadequate testing facilities such as those at Cape Canaveral for the successful prosecution of our present and contemplated programs Would you care to comment on that situation?

General PUTT. Yes. I guess we are in no different situation now than we have been in the past, at least in my experience. Testing facilities are always a difficult problem One must foresee considerably in advance of the actual need that facilities of some nature are going to be required.

In many cases the facilities themselves are quite a research and development problem, just to design the tools and then get them built.

So that in general our experience has been that from the standpoint of capabilities and timeliness we are always a little behind the race, sometimes a lot behind, in our own programs.

Now, the machinery of Government makes it difficult to get facilities timely and of proper scope and capacity. Most of our facilities are built with public-works funds. This is not an easy process, to go through all the process of authorization and appropriation. Lead time is great; the administrative lead time is great

Mr. FORD. The Bureau of the Budget?

General PUTT. The Bureau of the Budget, and all the agencies, of course, that must approve facilities and expenditure of funds.

It is really difficult to sell facilities when the need is not almost upon us. Then it is too late.

Mr. FORD. Would you say that the present construction program at Cape Canaveral or any other place is adequate for the missile and satellite programs which we are currently executing and working on?

General PUTT. I think at present, because of the priority and emphasis on ballistic missiles, that there is no lack of funds for the facilities at Cape Canaveral We wish that we had funds available sooner in the past so that it would not be such a nip-and-tuck operation now to get the facilities ready at the time the hardware is going to be there to test.

We are still running close on that.

But to the extent of our capabilities of actually designing and constructing the facilities that are needed there, there is no shortage of funds in that area.

Mr. FORD. Thank you very much.

Mr. BROOKS. Before counsel ask questions, may I say this.

Dr. Dryden was going to testify today, but the chairman has already announced that we will have to hear him later. His statement is available here.

I understand the press has it. If it is all right with you, Doctor, since some of the statements probably have gotten away from the committee room already, is it all right to assume that you have made that statement for the press and let the press carry that statement?

Dr. DRYDEN. Yes, or you can read it into your record.

Mr. BROOKS. I think tomorrow that will be up to the chairman. He will probably wish you to go over it so that we can ask you questions about it.

Dr. DRYDEN. Certainly. If you wish to regularize it, you can introduce it in the record and defer questions until later.

Mr. BROOKS. If there is no objection, it will be made a part of the record and if there is no objection by you, we will let the press print it.

Dr. DRYDEN. I am only trying to get out of writing a new statement.

(The statement referred to is on p. 401.)

Mr. FELDMAN. General Putt, is it not true that the recent Soviet satellites, as well as ours, could be regarded as part of the International Geophysical Year program and, therefore, do not set any precedent for future rulings on passage over various countries?

General PUTT. Yes, I think they could be thought of in that regard. Because the legal aspects of the problem have been so difficult, maybe this is a good approach.

Mr. FELDMAN. General, you mentioned that the Air Force has a project similar to the Army's, to get a man into space, other than the X–15. Can you tell us about it?

General PUTT The status of the project is the same as that mentioned by Dr. von Braun, but still not approved. In technical detail it goes a little bit further than the Army project.

Our goal here would at least be to have the vehicle make a couple of circles before returning to earth.

Mr. FELDMAN. How far along is the program?

General PUTT. Not much further than the study stage except there is some hardware that has been developed and being used in other programs that would be applicable to this at the time that such a program were approved.

Mr. FELDMAN. I think Dr. von Braun indicated that we might be able, or he might be able, to accomplish such a mission within a year. Do you think you could do likewise?

General PUTT I think we could do a similar program in a year. I do not believe we could do the program we have in mind in a year, which is a little more difficult. And I think it would reward us with more useful data than Dr. von Braun's program.

Mr. FELDMAN. Do you have any idea how long the project would take?

General PUTT. It would be of the order of a couple of years.

Mr. FELDMAN How does the United States stand in comparison with Russia in relation to the conquest of space?

General PUTT. This kind of question always becomes a little difficult because where one stands is the summation of where we stand in a lot of smaller areas.

In the conquest of space, of course, one must be concerned with propulsion systems, with guidance systems, with structures, and things of that nature.

So in answering the question, are we ahead or are the Russians ahead, one must attempt to summarize and average out all of the elements that are required to get into space.

Maybe I could best give you a feel for this It is my view that for the next 2 or 3 years, if the Russians chose to do so—and this is an important distinction, if they chose—I think that they could probably outperform us in some of the things that can be done in further exploration of space.

I feel reasonably sure that in the broad basic research leading toward space that on balance we are probably ahead. In the area of rocketry it would seem to me they may have a little edge on us there.

Mr. FELDMAN. When can we hope to go ahead of the Russians if we, to use your word, expend the thought, money, and effort required?

General PUTT. I think it is certainly going to take a lot of effort. It would seem to me to be at least 2 or 3 years before we might be even with them.

Of course, they are not going to be standing still, either. I think we have a pretty tough row ahead of us for the next 5 years and possibly a longer period of time.

Mr. FELDMAN. Turning to missiles, what future advancements are in store for our future ballistic-missiles programs?

General PUTT. In general, I think that advancements in high-energy fuels, both liquid and solid, are going to give us greater ranges, greater payloads, greater yields for any given weight of rocket

Certainly, going to the solid fuels is going to simplify our ballistic missiles. They are going to materially improve the reaction time.

The logistics problems with solid propellents are much simpler than liquid propellents. I think you will find them getting cheaper, and smaller. Their guidance should be improved.

There is quite a broad base that we have developed that is going to lead to considerable improvements in our ballistic missiles.

Mr. FELDMAN. What are the prospects for ascendancy in the race between ballistic missiles, the antimissile missiles, and the countermeasure antimissiles?

General PUTT. Although the problem has become more and more difficult as weapons become more and more sophisticated and complicated, I do not see any significance between the measure and the countermeasure race, so to speak, with missiles than we have had with other military weapons and aircraft.

At one period of time the offense will be in the ascendancy and at other times the defense seems to be in the ascendancy.

I predict we will find in space weapons the same sort of race between the measure and the countermeasure.

Mr. FELDMAN. How successful would photography and other information be, that is, information acquired, in a vehicle carrying out a military reconnaissance mission?

I am referring now to the techniques.

General PUTT. I think they will be very successful. Enough work has been done in this area to indicate very great promise that we will have photography and television that will give us real usable reconnaissance data.

Mr. FELDMAN. Could satellites be used for active rather than passive defensive purposes?

General PUTT. I think this would be feasible. There are a lot of questions as to whether it would be practical for the way one would want to carry on a defensive campaign. There may be easier, better, and cheaper ways of doing it, but I certainly would not discount the possibilities of using satellite vehicles of some sort or nature as offensive, active weapons.

Mr. FELDMAN. Could the satellites carry their own defensive measures?

General PUTT. This is conceivable in some forms. Again it might be a question of feasibility and still be quite impractical, but I certainly would not rule the possibility out.

Mr. FELDMAN. What would be the military role of the manned orbiting vehicle?

General PUTT. At the present time it is difficult to foresee that mechanical gadgets in the sky with computers, but lacking human intelligence and judgment, will be able to perform all of the missions of reconnaissance and bombing of targets for a considerable period of time.

There is always going to be unknown targets. There may be fleeting targets.

For a period of time we may not know accurately enough the actual location of targets with relation to launching points to get ballistic missiles on them, so that it seems to us that the man is still required whether we are flying in the sensible atmosphere or outside of the sensible atmosphere into space.

Mr. McDONOUGH. General, you used the words "sensible atmosphere" several times this morning. I would like to have you define that. I do not get the point.

General PUTT. This is a term that is used in the scientific community, I guess. It generally, I think, means that level at which there is sufficient atmosphere to support winged flight.

Dr. DRYDEN. Or where the forces due to the atmosphere are an appreciable element to propulsion.

Mr. McDONOUGH. It would be inner space, then?

Dr. DRYDEN. It would still be closer to inner space. Part of the atmosphere where Sputnik 2 just burned up is certainly sensible atmosphere because it got red hot.

Mr. McDONOUGH. I do not understand the word sensible.

Dr. DRYDEN. You can detect it.

Mr. McDONOUGH. It is detectable by the senses of man?

Dr. DRYDEN. That is right.

Mr. BROOKS. May I suggest this question there? I thought from the use of the words "sensible atmosphere" that you had in mind that in space the variable influence affecting flight would be simplified by not having air currents and things of that sort.

Would you want to express yourself on that?

General PUTT. Well, we certainly get away from some problems out in space that result from having an atmosphere. In getting back to earth from outer space one must make this reentry into the atmosphere and, of course, the forces would become quite great.

So in going into space we acquire some new problems and we get rid of them too, as long as you stay there.

When you come back in you have all of them.

Mr. McDONOUGH. It is beyond the drag area?

General PUTT. Yes.

Mr. McDONOUGH. Within the drag area is sensible atmosphere?

General PUTT. That is right.

Mr. FULTON. It includes then the thermosphere, but it does not include exosphere?

Dr. DRYDEN. That is roughly correct.

Mr. FULTON. And it does not go out beyond a thousand miles?

General PUTT. No.

Mr. FULTON. Where the atmosphere ends. Is that right?

General PUTT. Yes.

Mr. FELDMAN. What might be the future relationship between space-vehicle missiles and aircraft, missile-launching submarines, and other systems?

General PUTT. Thinking in terms of warfare, it certainly would be dangerous to base your operations on a single strategy. It is equally as dangerous to base your operations on a single weapon so that it appears to us to be very important that we have families of weapons so that the enemy does not know which one you are going to use. It complicates his problem in developing countermeasures for a multiplicity of different weapons than if you just had one.

So it would be extremely dangerous to concentrate on one, and, therefore, I think to the extent that the country is able to afford it, there should be a variety of weapons to carry out military operations.

Mr. FELDMAN. Addressing ourselves to the NASA legislation, what in your opinion should the scope of the NASA be in the space field?

General PUTT. Here, I believe that, if we can use the analogy or the example, it seems to me that NASA should perform almost the same role across the board, aeronautics, space, and its relationships, with all the agencies of the Government in essentially the same manner and the same method that has been practiced in the past within the area of aeronautics.

In other words, they would direct the civilian research programs. They would aid the military in their programs and the military certainly would want to look to the NASA for the basic research and knowledge, fundamental knowledge, that would be usable by industry and the services for the development of any military weapons that might be developed for utilization in space.

So I view their role and their relationships as just remaining practically the same except extending in scope from conventional aeronautics into space.

Mr. FELDMAN. The emphasis on the scope, at the present time, is in an advisory capacity. Is that not true?

General PUTT. No, this I do not believe is true. While that is in the name, National Advisory Committee for Aeronautics, they actually carry out research and development in aeronautics, aeronautical science.

It is true that they do render a lot of advice and helpful advice, to the military services, particularly on problems in the development of military weapons.

So that they do act in an advisory capacity, but in addition they have operating responsibilities.

Mr. FELDMAN. The emphasis, though, is on advice rather than on operations. Is that right?

General PUTT. I would think it was the other way around. If one considers the scope of their facilities and their operations and what not, I think the major emphasis is on actual operations.

Mr. FELDMAN. Is it your testimony that they have a great deal of know-how in the development of scientific techniques of that sort?

General PUTT. That is correct.

Mr. FELDMAN. The proposed NASA legislation changes the relationship of the Board and the Director and the method of selecting the members of the Board, the DOD membership, from that of the NACA.

What are your views on this portion of the proposed legislation?

General PUTT. I certainly would like to see the new agency function as it has in the past. I believe in the new legislation for the agency the Board itself becomes advisory to the Director.

I believe the best description of the relationship of the Board to the Director at present is that they really do act in an executive capacity so far as programing, planning, and budgeting are concerned.

They act like a sort of board of directors for the Director and the NACA.

I have not conferred with Dr. Dryden, but it seems to me this has worked so extremely well that to upset that kind of operation would be disappointing, at least to me.

I wonder whether a board that is advisory only, and meets only once every 4 months, as I believe the legislation calls for, whether you would get the intense interest, the caliber of people and whether they would be of the assistance to the Director that the present Board is.

Mr. FELDMAN. You just said you would like to see them operate as they have in the past. The only other function that we would add to it is this jurisdiction in outer space.

Then do you think it would take legislation, or it should take legislation to accomplish that purpose, or could it be done by Executive order?

General PUTT. I do not believe I am enough of a legal mind to comment on that.

It would seem to me that there are advantages in having it a subject of legislation to expand the scope of activities.

Mr. BROOKS. Of course, that does change the fundamental purpose of the agency by asking it to take over space.

General PUTT. That is right.

Mr. BROOKS. I want to ask you this.

What, in your mind, is going to be the essential difference between the NACA, that is, the National Advisory Committee for Aeronautics, and NASA, the agency referred to in the bill? Would they not be advisory? Would they not both be advisory?

General PUTT. It would seem to me that NASA would still function in an advisory capacity in the same way that they have in the past.

Mr. BROOKS. It is proposed to be a new agency.

General PUTT. It does seem to me that it has somewhat of a greater responsibility for the national program in space than it has had for a national program in aeronautics.

Dr. DRYDEN. Mr. Chairman, the bill, of course, provides that NASA shall at least direct the firing of satellites to obtain information in outer space, that they should be responsible for actual developments that are needed in the advance of the civil-space question and it will require a considerable change in the NACA, there will be a wholly new operation which will largely have to be operated by contract-type operation.

Mr. BROOKS. How would you differentiate between the two? Is there not a good deal of overlapping there?

For instance, would not both be advisory and would not both be also an operating agency for experimentation?

Dr. DRYDEN. The advisory feature has been very limited. That name has been obsolete for something like 30 years.

Mr. BROOKS. You mean NACA?

Dr. DRYDEN. The NACA name. The term advisory is obsolete. In the early days they did advise the Government on setting up the Civil Air Commerce Act.

Mr. BROOKS. That is true, and they have an extensive program for development there, but they still are advisory, are they not?

Dr. DRYDEN. The present advice is technical advice, if I can make a distinction between a group that advises on technical matters and one which gives overall advice on aeronautical matters in general.

Mr. BROOKS. NASA would be theoretical?

Dr. DRYDEN. NASA would do the same thing. It also would be engaged in actual operations. It has not yet been determined which specific projects now handled by the Advanced Research Projects Agency will be handled by the new agency.

For example, the type of operation embodied in the lunar problems would become the responsibility of the new agency rather than the Department of Defense.

That is a large operation as compared with our present laboratory operations.

Mr. BROOKS. The Advance Research Projects Agency would be under the Defense Department, but it will cover the same field?

Dr. DRYDEN. No. The President, as you know, has stated that these projects are to be examined to decide which will be transferred to the new agency. The approval for conducting the civil program in the Advanced Research Projects Agency is a temporary thing, subject to reexamination.

Mr. BROOKS. Does not the law make it other than that?

Dr. DRYDEN. The law says they have the responsibility until February of next year. This is the present legislation.

Mr. FULTON. On that point, Mr. Brooks, I have a question.

Would legislation to establish this National Space Agency, that has in it a provision limiting the Department of Defense to only those projects that have a well-defined military application, injure or weaken the Department of Defense in your opinion?

I would like to ask both the General and yourself, Doctor, that question, for the record.

Dr. DRYDEN. I think you realize I did not write this particular language. The determination of the policies in this matter lie with the President and the Congress.

Mr. FULTON. Would such a limitation weaken the Department of Defense or ARPA?

Dr. DRYDEN. It depends on its interpretation and this is not completely clear, I think, at the moment.

Mr. FULTON. You would disagree with Dr. York, who yesterday felt such a provision would weaken the Department of Defense and ARPA?

Dr. DRYDEN. It would weaken them in the sense that they are not doing the whole space job, civil and military. That weakens them by taking part of the work away, if you want to call it weakening the Department of Defense.

I do not think it will weaken the defense of our country to have this transfer made.

Mr. FULTON. So the overall program would be strengthened by such a provision?

Dr. DRYDEN. The overall program would be strengthened by this.

Mr. FULTON. I would like the General to answer that, too, if he will.

General PUTT. As Dr. Dryden said, the present language is subject to interpretation and so far as the responsibilities for the research that

the military can carry out, we would like to see that expressed as now contained in the President's Executive Order 51021, which does permit the military services to engage in basic research that is closely allied to military problems.

Mr. FULTON. So that would be a better statement, really, than a well-defined military reason?

General PUTT. We think so. The well-defined military reason is subject to some interpretation.

We like the language of 10521.

Mr. FULTON. At that point, would you put the language in the record with the chairman's permission?

General PUTT. Yes.

Mr. FORD. I would have no objection to the language being included in the record of section 10521 so that we may have it for reference.

Mr. FULTON. And also the language of the administration bill in the record, for comparison at this point.

Mr. BROOKS. You mean insert the entire bill?

Mr. FULTON. No; just this provision.

Mr. BROOKS. If there is no objection, it will be so ordered.

(The material referred to follows:)

The following language is extracted from section 4, Executive Order 10521, administration of scientific research by agencies of the Federal Government, dated November 17, 1954: "the conduct and support by other Federal agencies of basic research in areas which are closely related to their missions is recognized as important and desirable, especially in response to current national needs, and shall continue " The language noted above is preferred to the following language of H. R. 11881, page 2, lines 7 through 10.

"The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States, except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense."

Mr. BROOKS. Now, Mr. Metcalf.

Mr. METCALF. I was interested in Mr. Feldman's questions directed to General Putt. I would like to ask Dr. Dryden this:

In view of the statements that have been made, the General says he would like to see the new agency function as it has in the past.

In your outline the functions of the new agency would largely be an expansion of some of the duties and performances you have made in the past.

Again, what is the need here for legislation?

Dr. DRYDEN. The need for legislation is a very simple fact that there is not in any one agency all of the skills involved in the space program NACA, for example, does not have any laboratory devoted to research and communications, guidance control. Legislation will be necessary to give us the broad contracting authority necessary to operate in that fashion in this area which is needed in the space program.

The second point I think the lawyers can perhaps argue, I don't know. I feel much happier with a clear statement that we are empowered to operate space vehicles, rather than rely on some interpretation.

Aeronautical research never has been fruitful in the absence of close contact with flying. The NACA, as you know, operates aircraft, does flight research on aircraft.

General Putt will give us an airplane costing $5 million, turn it over to us for scientific experiments. We feel in the space field research will be fruitless unless it is coupled with actual space experiments.

It seemed to us that this authority is specifically needed.

Mr. BROOKS. Do you think the Comptroller might question your expenditures?

Dr. DRYDEN. Exactly.

Mr. METCALF. That may well be true, that for certain technical reasons it is necessary to have authorizing legislation, but as I gathered from the testimony here today, it is only contemplated that this new agency, NASA, is going to function about as the former NACA has functioned with some broadened authority, but function along the lines—and you desire it to function along the same lines—that you have functioned in the past?

Dr. DRYDEN. Yes.

May I say I have much sympathy with this point of view. I started out a year ago with the idea that the public should be educated to the fact that aeronautics was an expanding concept.

As General Putt so well expressed in his testimony, we are spreading further, the same elementary sciences are needed, no change will be necessary in need.

This proved to be a losing game. Astronautics is quite different from aeronautics in the public mind. It is true in some areas that have been referred to, Ion motors which have no application to the atmosphere, there are some areas in which we have to move to get in to outer space that are not immediately in our knowledge.

Mr. METCALF. I think that is the whole crux of the matter before this committee, the various research problems with which you are going to be concerned, if you are the Director of the new agency.

The committee wants to know where the space astronautics thing will be in the Government. That is our basic mission.

That is why I am making this inquiry because I do not know where it should be.

Mr. DRYDEN. Space is too big to be in one agency. It has a civil as well as military aspect.

I am sure you are familiar with the argument for not putting the civil side of things wholly within the military. It immediately would make almost impossible the discussion of peaceful uses of space and international cooperation.

I do not believe it is right to write the military out of space. I believe it would be an equally serious error to put all of space in a purely civilian agency.

Mr. METCALF. The thing that troubles me is that I agree with you and I am a little bit unhappy, to use your phrase, about putting this thing in a glorified and just a little bit amplified NACA. That seems to be the direction in which this legislation is going.

Dr. DRYDEN. I think the legislation going that way sets up a completely new agency. Instead of setting up an office in some other building and putting out its employment opportunities for people who have to come from our place and from the military, instead of coming to Congress to reproduce the facilities that we already have which enabled the study of these reentry problems, this proposes a new agency

which uses the resources of trained manpower, trained teams, facilities that are available.

It is not the NACA. This bill is not the NACA as it now exists if you read it carefully.

General Putt said he favored the NACA as it now exists.

Mr. McDONOUGH. Are not the two problems so correlated that you could call it a national aeroastronautics agency?

Dr. DRYDEN. Yes.

Mr. McDONOUGH. That would encompass both sensible atmosphere and outer space.

Dr. DRYDEN. There have been bills introduced which propose a different name, NACAA, National Advisory Committee for Aeronautics and Astronautics.

This is a matter of name. I think advisory is not the proper adjective in the name.

Mr. McDONOUGH. The thing you want to do is be back here. The idea of building up bureaucracy is too much. We do not want to have 2 office buildings where we can operate in 1 and do the same thing.

Mr. FULTON. Would it not be advisable, though, to have a civilian agency which has the direct primary responsibility for an overall civilian-military research, development, and exploratory policy, as well as the overall primary responsibility for implementing those various programs.

That is, combining all the functions under one policy making civilian agency, with military given its adequate place.

Dr. DRYDEN. Of course, you are now speaking of a very controversial matter, whether to take the role of research from the military departments and set it up outside in a civilian agency.

I personally have not been in favor of that solution because I think it divorces the science too much from the military.

Mr. FULTON. My intention is not to take from the military the programs that are related to military functions as well as basic research which might be allied. We cannot tell now, but they might feel it is within their power.

I feel we should have outer space not just explored, but conquered by the military.

Dr. DRYDEN. I think you are talking about what I suppose the bill is intended to accomplish.

Mr. BROOKS. Gentlemen, there is a quorum call. We are not going to be able to finish. We have finished with General Putt, but we have gotten into an area we will not be able to finish today. What is the pleasure of the committee?

If there is no objection it would seem to me that the thing to do is to adjourn until tomorrow morning at 10 o'clock.

We thank you very much, General Putt; we have finished with you. We would like to have Dr. Dryden at a later date.

General PUTT. Thank you very much, Mr. Chairman.

(Thereupon, at 12:40 p. m., the committee was recessed, to reconvene at 10 a. m., Thursday, April 17, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

THURSDAY, APRIL 17, 1958

House of Representatives,
Select Committee on Astronautics
and Space Exploration,
Washington, D. C.

The committee met, at 10 a. m., pursuant to recess, in the Caucus Room, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack, Brooks, O'Brien, Metcalf, Natcher, Sisk, McDonough, Fulton, Keating, and Ford.

Present also: George J. Feldman, Director and Chief Counsel.

The Chairman. The committee will be in order.

We are very happy to have as the first witness today and are glad to welcome Maj. Gen. John B. Medaris, whose outstanding work in connection with the international interest of our country on the part of the Missile Command is well known.

We are glad to have you here with us, General, and we shall be glad to hear your testimony.

STATEMENT OF MAJ. GEN. J. B. MEDARIS,[5] COMMANDING GENERAL, UNITED STATES ARMY ORDNANCE MISSILE COMMAND

General Medaris. Thank you, Mr. Chairman.

Mr. Chairman and gentlemen of the committee, with your permission I should like to start with a short prepared statement, after which I shall be wholly responsive to the questions of the committee

First of all, I want to thank you for this opportunity to appear before you. I am here as the commanding general of the United States Army Ordnance Missile Command

After giving you a brief summary of the command's activities, I will be fully responsive to your questions.

The United States Army Ordnance Missile Command was recently established to assure full coordination and utilization of the facilities and technical resources of the Army Rocket and Guided Missile Agency, the Army Ballistic Missile Agency, White Sands Proving Ground, and Jet Propulsion Laboratory.

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[5] Maj Gen. J. B. Medaris is commander of the Army Ballistic Missile Agency. His responsibilities include the development and establishment of the Redstone and intermediate-range ballistic missiles as weapons systems for the United States Army.

Born in Milford, Ohio, on May 12, 1902, he enlisted in the United States Marine Corps in 1918 and served in France during World War I.

In 1921, he was commissioned as a lieutenant of infantry and served with the 29th and 33d Infantry Regiments until detailed in the Ordnance Corps in 1926

In October 1927, he resigned from the Army and for 10 years engaged in merchandising and management advisory activities in the business world

In July 1939 he returned to active service and served successively until 1942 as executive officer, Cincinnati Ordnance District; assistant, district control office, Office Chief of Ordnance, executive, Contract Distribution Section, Office of the Under Secretary of War (with Secretary Patterson).

In spring of 1942, he took to the field and was successively battalion commander, ordnance officer, II Corps—campaign in Tunisia, invasion of Sicily and Sicilian campaign

Later he transferred to England as ordnance officer for the First Army and planned and executed ordnance portion of First Army's invasion of Normandy, remaining as ordnance officer for that Army's campaign in Europe.

After V-E Day, he served in turn as ordnance officer, Fifth Service Command, ordnance officer, Army Ground Forces; Chief, United States Army Mission to Argentina from 1949 to 1952.

Returning in June 1952, he became executive and Assistant Chief, Ammunition Branch, Industrial Division, and in May 1953 he became Chief of the Ammunition Branch, which position he held until his assignment as Assistant Chief of Ordnance and Chief of the Industrial Division of the Office, Chief of Ordnance, in November 1953

He was promoted to the rank of major general on September 15, 1955.

In Number 1955, he was designated as commanding general of the Army Ballistic Missile Agency

Among the decorations he has been awarded are the Distinguished Service Medal (for the European invasion and the campaign following), the Legion of Merit, Bronze Star Medal, Soldier's Medal, and the French Legion of Honor.

At present, the Army Rocket and Guided Missile Agency is responsible for the development and industrial production of surface-to-surface antiaircraft missile systems and comparatively short-range surface-to-surface missile systems.

This agency is also engaged in the development of the Nike-Zeus antimissile system.

The Army Ballistic Missile Agency is developing the longer range ballistic missile systems, including Redstone, Jupiter, and now Pershing. This agency and the Jet Propulsion Laboratory are also engaged as a team in a satellite program which, as you know, has enjoyed considerable success to date, and I feel has demonstrated the Army's ability to efficiently coordinate and manage joint military-civilian scientific programs designed to yield scientific data.

Dr. von Braun is Director of Technical Development at ABMA. Beyond the field of ballistic missiles, our integrated development team led by Dr. von Braun is recognized as one of the leading scientific groups in the outer space field.

In fact, the first real emphasis on satellites in the United States came from Dr. von Braun, beginning about 10 years ago, and continuing through our successful launching of the first United States satellite and into the satellite program which we are now pursuing.

The term "integrated development" is our word for the development techniques which have been utilized in keeping Jupiter, our highest priority program, on schedule.

To accomplish this, the Redstone and Jupiter programs were placed under the same management so that the Jupiter program could take maximum advantage of the successes of its predecessor, the Redstone. Development of Redstone was carried forward, and production of the system for tactical employment is now underway and progressing very satisfactorily.

The establishment of the United States Army Ordnance Missile Command will permit ever broader application of these techniques.

In conclusion, I would like to make a few points clear. The United States Army Ordnance Missile Command is an experienced organization of thoroughly demonstrated capability. It is under the direction of the Army Chief of Ordnance.

Additionally, it has the unique advantage of immediate access to the Secretary of the Army and the Chief of Staff, when required.

It is further vested with command of all Army resources which relate to the execution of certain special priority missions. It serves national interests with the full measure of all Army resources, without any limitations as to whether either the end items produced or the knowledge gained are to be devoted to the sole use of any one military service.

We are doing this today by supplying the Air Force with Jupiter missiles and by giving this streamlined, integrated support to the Advanced Research Projects Agency in a national program of the utmost urgency.

We make maximum use of the expert advice and detailed scientific knowledge which are available from all sources in any field.

We frankly feel that we have built up an enviable record of accomplishment in meeting schedules as predicted and within our estimates of costs.

In light of this record, we certainly do not intend to commit ourselves to anything that we do not think we can accomplish.

This has been a very brief statement of our past record and present activity. I will now be pleased to respond to your questions.

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. General Medaris, I should like to ask you this. The United States Army Ordnance Missile Command is under the Ordnance Command?

General MEDARIS. That is correct. It is under the Army Chief of Ordnance.

Mr. BROOKS. What is it? Is it in the nature of an addition to the Ordnance Command?

General MEDARIS. It is a major field command of the Ordnance Corps.

Mr. BROOKS. How many commands do you have in Ordnance?

General MEDARIS. Major commands, there are four.

Mr. BROOKS. Are there any others related to missiles?

General MEDARIS. None.

Mr. BROOKS. Or satellites?

General MEDARIS. No, sir.

Mr. BROOKS. Or scientific exploration and experimentation?

General MEDARIS. Not in that area, sir.

Mr. BROOKS. So this is the only one which is under Ordnance that has any authority over missile development?

General MEDARIS. That is correct, sir.

Mr. BROOKS. Now, what is the specific difference between the Army Ordnance Missile Command and the technical development program?

General MEDARIS. I believe you refer, sir, to the technical development group under Dr. von Braun.

Mr. BROOKS. That is correct.

General MEDARIS. That is a part of the command, sir. It is a major segment of one of the elements of the command, the Army Ballistic Missile Agency.

Mr. BROOKS. Then Dr. von Braun is under your command?

General MEDARIS. That is correct, sir.

Mr. BROOKS. Does he have free rein in his experimental work? Is he subject to military discipline?

General MEDARIS. I don't think Dr. von Braun could be considered subject to any kind of discipline other than his own.

Mr. BROOKS. He is a very able man. I should think if he was put under military discipline he could take it like any of us.

General MEDARIS. I am sure he could and he is a very fine coworker; he is a fine man to work with. No one in the world, I believe, can really have complete freedom of action. We are all limited by such things as money and time and priority among the things that we must do and we all want to do more things than we have time for or money for.

Mr. BROOKS. Now, the Advanced Research Projects Agency—I believe that is the name of it—is a part of the Defense Department and you are a part of the Department of the Army

General MEDARIS. That is correct.

Mr. BROOKS. How will you work together?

General MEDARIS. My command works directly for the Advance Research Projects Agency in any project that its Director wants to assign to us.

Mr. BROOKS. Do you take orders in that respect from ARPA?

General MEDARIS. That is right.

Mr. BROOKS. Who has control of it, ARPA or the Army?

General MEDARIS. The ARPA controls their own projects. We stand in the same position as a contractor would to them, and we take their direction of the project. It is their project, their guidance, their directing it, and we are responsive to their desires.

Mr. BROOKS. Is ARPA now in charge of the satellite program, the Jupiter program, the Pershing program?

General MEDARIS. No, it is in charge of the satellite program. The Jupiter and Pershing programs, as military weapons systems, are not under ARPA.

Mr BROOKS. So your differentiation there is what is of a military nature and what is not?

General MEDARIS. The charter of the ARPA indicates that the Secretary of Defense will assign to that agency such advanced projects as he deems necessary within his concept of their mission. He has assigned to them the entire satellite and forward research field in those advanced areas

Mr. BROOKS. Now, do you have the facilities there in your command that you need for this work?

General MEDARIS. We have been very successful in managing to get most of the facilities that we need.

Mr. BROOKS. What do you lack, then? You say "most."

General MEDARIS I would not say as a conmander that I could ever say I was completely satisfied There is always something I would like to have.

On the other hand, we have what we require to do our job, sir.

Mr BROOKS. That is at the Redstone Arsenal?

General MEDARIS. Yes, sir, and at the Jet Propulsion Laboratory on the west coast.

Mr. BROOKS. Those two plants are under your command?

General MEDARIS. That is correct, sir.

Mr. BROOKS. What about Banana River? Do you have what you need there?

General MEDARIS. Yes, sir; we have what we need at the test range at Cape Canaveral.

Mr. BROOKS. You require material or additional facilities to continue this program?

General MEDARIS. There will always be additional facilities required because as the programs grow and the areas you go into grow, you have to have new types of technical resources to meet them.

There is no tremendous major facility requirement in connection with these programs as they stand now. There will always be small facilities requirements for any new program.

Mr BROOKS. But the major portion of your needs is satisfied?

General MEDARIS. That is correct.

Mr. BROOKS. By what you have already done?

General MEDARIS That is right, sir.

Mr BROOKS Now, are you satisfied with the progress of this program?

General MEDARIS. Well, again, I might say that anyone who is really interested in accomplishments is never quite satisfied. If I was entirely satisfied, I might become much too relaxed

We would like to go as far as we can.

Mr BROOKS Is there any way we can help you to go any faster?

General MEDARIS. I think at the present time, Mr. Congressman, that the resources that we have are being well utilized under the

direction of ARPA. We have constructive projects ahead of us and adequate to occupy our resources and our abilities for the immediate future.

Mr. BROOKS. Are we putting emphasis on the right part of your program? I mean legislatively. I will repeat that in a different way.

Are there any suggestions you can make as to how, legislatively, we could prepare a setup here in the Congress which would put more emphasis on the proper part of your program?

General MEDARIS. I think, Mr. Congressman, that the constitution of this committee is in itself a significant contribution and spells out this particular area as being of concern and importance and recognizes the need for attention to it.

Beyond that, I think the Congress has been extremely cooperative and helpful.

Mr. BROOKS. Well, a committee of this sort would be restricted to outer space, more or less, as I see it. What would be the restrictions, in your mind, if you were limited to the developments of outer space?

General MEDARIS. You mean if the resources of my command were so limited? This would be very unfortunate, because it is a balanced set of resources that is intended to carry forward the missile art and provide the Army with its requirements in terms of missile weapons.

At the same time, it has the capability and needs to continually move forward in the scientific field of exploration in order to advance its capability and we also are able and have capability of supporting scientific outer-space projects.

Mr. BROOKS. Would you refer to missiles as outer-space weapons?

General MEDARIS. The missile art is the basis for the outer-space use. It is the takeoff point.

The CHAIRMAN. It is hard to separate, too, is it not?

General MEDARIS Very hard to separate, Mr Congressman.

The CHAIRMAN. One leads to the other?

General MEDARIS. I believe so.

The CHAIRMAN. You cannot divide the situation.

General MEDARIS. I have a great deal of difficulty trying to do so in my own head because the cross contributions are continuous, all the time, every time something feeds back and forth from the scientific to the military.

Every new scientific development historically has given a concept to someone of how it might be used as part of a future weapons system.

So there is a great deal of interplay.

Mr. BROOKS. Certainly, the satellite program would be an outer-space program?

General MEDARIS. Yes, sir.

Mr. BROOKS. The platform program would be outer-space program?

General MEDARIS. Yes, sir.

Mr. BROOKS. Programs of that sort are well settled to be related to outer space?

General MEDARIS. Yes, sir.

Mr. BROOKS. The short-range missiles certainly are on the borderline?

General MEDARIS. Of course, when we consider space technology we are taking off from the point where a missile is a surface-to-surface weapon. That is, it is coming back to a point in earth as its immediate destination.

Its purpose is not to continue outside the atmosphere.

We consider any earth-based weapon, that is, to attack something above it, as being not a space weapon, although I suspect that the time will come when we will launch space weapons from earth bases. But I am referring here to the presently envisaged air-defense systems. And we are really talking in space technology about any kind of object or instrumented object of investigation or manned object that is going to remain for a considerable time outside the sensible atmosphere.

And, some defense, therefore, must be developed against these techniques which will be quite different from those used for aircraft.

It is going into and staying within that portion of outer space where aerodynamics don't operate, where you cannot use airfoils as control surfaces.

That is what we think of as the outer-space area.

Mr. BROOKS. Let me ask you this question, then.

You work with the NACA?

General MEDARIS. We cooperate with them. We have people on some of their subpanels; that is correct.

Mr. BROOKS. Is there any overlapping of jurisdiction with your work in NACA?

General MEDARIS. There has not been to date; no, sir. NACA has under its control certain resources that we have used in programs ourselves, such as the wind tunnels that they have. We have asked the NACA to do a few investigative projects for us which they have done. But that has been asking them to do it for us against our projects and with our money.

Mr. BROOKS. Is there any overlapping of jurisdiction between that and ARPA?

General MEDARIS. Mr. Congressman, I am going to have to beg off on this one because it gets a little more complex than I have been able to follow.

Frankly, I do not know. It does not impinge on my work at the moment, so I really don't know how much overlap there might be.

Mr. BROOKS. Well, the Advanced Research Projects Agency is a new agency and it would be a little different.

General MEDARIS. That is right.

Mr. BROOKS. That is all, Mr. Chairman.

The CHAIRMAN. General, can you give us any information, without violating any classified obligations, as to how far we have progressed in the field of intermediate and intercontinental ballistic missiles, having in mind the relative situation with reference to the progress of the Soviet Union?

General MEDARIS. There are some known facts, Mr. Chairman, that can be given openly.

It is a known fact that the Soviet Union has successfully fired an intercontinental ballistic missile over the full intended range.

The CHAIRMAN. What is that range?

General MEDARIS. In excess of 3,000 miles.

I would not want to define it exactly. We don't know exactly its range capability, but we know pretty well what it is.

In this sense we know that, of course, they are ahead of our intercontinental missile program. Those programs belong to the Air Force and, as a basic principle, I would rather have people answer for their own programs.

I do not consider myself in a position where I should comment on somebody else's job.

The CHAIRMAN. In the field of intercontinental ballistic missiles and intermediate missiles, is the Soviet Union way ahead of us?

General MEDARIS. I think there is no question about that; they are definitely ahead of us.

The CHAIRMAN. Is there any idea how far ahead they are?

General MEDARIS. It is a very difficult thing to measure. I think we have had more difficulty unsnarling some comments that have been made on that subject than anything else. Because how far ahead they are has to be handled in 1 of 2 ways, Mr. Chairman. Either we have to take point by point the various technical areas and relate what they know that we don't, or what they have done that we have not done, or if you want to put it in other terms, it is a question of how fast they are moving and how fast we are moving.

If they are still moving faster than we are, then they are an infinity of years ahead of us because we will never catch them.

If we are moving faster than they are, how long it will take us to catch up will be determined by how hard we work.

The CHAIRMAN. Can you give us any information as to the progress made by the Soviet Union—we hear about antimissile missiles but I will confine it to anti-intercontinental bombers—as a defense against our intercontinental bombers?

General MEDARIS. They have devoted a great deal of energy for quite a few years to an extensive system of their defense against such planes. I would not feel free to go into details as to the extent of their capability and I am sure that the committee could get that information from the Intelligence people in a briefing.

The CHAIRMAN. Is it your opinion that in the troubled world today it is vitally important that at all times we be in a position where although we are committed to a policy of nonaggression, that we be able to retaliate in case of an attack?

General MEDARIS. It is my conviction, Mr. Chairman, that we cannot afford under any circumstances to let ourselves get into a position where a single unexpected massive strike would completely cripple our resources to the extent that we could not deliver very heavy punishment on the initiator of that type of aggression.

I believe that so long as we stay in the position where, regardless of what he does, there can be a strikeback, and regardless of the conditions of his defense, there can be a strikeback, and an effective one, I don't think it will occur as long as we stay in that position.

The CHAIRMAN. In other words, the law of self-preservation?

General MEDARIS. That is right.

But the deterrent force has to be visible. It has to be known to exist and it has to be effective and capable of doing its job regardless of the other fellow's defenses.

The CHAIRMAN. The more people realize that, and with a sound public opinion supporting such a policy, the better it will be for our country?

General MEDARIS. Naturally.

The CHAIRMAN. In other words, it will be a sad day—I would never admit defeat, but it would be a sad day—if the day ever arrived when they could hit our targets and we would have difficulty hitting their targets?

General MEDARIS. Yes, sir; because this is always a temptation to

anybody who is grasping for power. If they have the capability of doing an effective unilateral act and not being punished for it, they may overcalculate what the results will be and if they think they can win in one heavy strike, it is a temptation to do so.

The CHAIRMAN. And even more than power when they are dedicated to world revolution and world domination?

General MEDARIS. That is correct.

The CHAIRMAN. That is quite an important key at this time, is it not? That particular situation is something that we cannot under any conditions ignore?

General MEDARIS. I feel that we must not ignore it. If his technology advances and his capabilities and the capability of any hostile military power to strike us increase or change, we must change and vary our abilities to meet it and strike back.

So that we cannot get behind. We must stay ahead.

The CHAIRMAN. And the American people must realize that they have to pay the price and make sacrifices?

General MEDARIS. It is an untidy world and at the moment we have to live with it.

The CHAIRMAN. And in connection with this important activity the American people had better expect failures in the making of tests, but out of failures come future successes.

In other words, they cannot quibble over the fact that something is tried and may not be a success at a particular time?

General MEDARIS. No, sir; because if you don't try you will never do anything. If the only thing we tried to do were those things that we knew enough about and knew so thoroughly that we could always succeed the first time, you could be sure that we were not trying enough, that we were not far enough out. Any progress is based on failures as well as successes. It has to be

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. In order to present some of the problems concerning outer space and exploration, our chairman, Mr. McCormack, has introduced a bill, H. R. 11881. General, have you had a chance to read that bill?

General MEDARIS. Yes, sir; I have.

Mr. NATCHER. This bill makes certain provisions concerning outer-space exploration, one of which is that a civilian agency is to exercise control over aeronautical and space research sponsored by the United States except insofar as such activities may be peculiar to, or primarily associated with, the weapons systems or military operations, in which case the agency may act in cooperation with or on behalf of the Department of Defense.

How do you feel about that provision, General?

General MEDARIS. As the provision is written, Mr. Congressman, it adequately covers, I am sure, the desires of the chairman and it is well expressed.

I cannot comment on the legal language. The operation of any system of this kind is going to depend on good people making it work.

Mr. NATCHER. General, do you not feel that activities such as the ones provided for in this bill should be under the control of a civilian agency?

General MEDARIS. I have only one problem, Mr. Congressman, and that is that neither this bill nor succeeding events can completely define in all cases where this division point is.

Now, if it develops in such a way that there is a very closely knit cooperative effort between this agency and the Department of Defense, and a mutually supporting arrangement, so that there is no quarreling or quibbling over the shadow zones in a thousand places, if it is a question of where it is going and into what it is going to develop, then there is no reason why it could not be an effective answer.

On the other hand, as I say, the only things that trouble me are the fact that I find it very difficult in my own mind, with assurance, to divide out the scientific, the peaceful, and the military, in terms of any kind of intensive forward research.

This does not mean that this kind of organization cannot do it effectively. It means that it is going to require the close cooperation of well-intentioned people.

The CHAIRMAN. As I interpret your mind, would it be a fair interpretation broadly to say that, while you believe in a civilian agency in the world of today and the immediate future, the military should not be put in a subordinate or secondary position?

General MEDARIS. I am not thinking in those terms, either, Mr. Chairman. It is not a question of who is on top and who is on the bottom.

We in the military are dedicated to the principle of civilian control of our military affairs. We believe that is a proper and essential basic part of our system of government

We have no quarrel with that. What worries me, Mr Chairman, is that it has been difficult in the past under military programs, recognized as weapons programs, to be able to justify and secure the funds and support for the type of forward-reaching research which in its turn will develop new weapons systems.

I am somewhat fearful that the more the scientific and military are divided, the more difficult it will be for us to really go forward in the research area in those things that must be done now if the next generation of military weapons will be as good as those which we may meet on some field of battle. This is my fear.

Mr. NATCHER. General, I have here a copy of the report from the Special Committee on Space and Astronautics of the Senate It appears that you testified before the Senate Preparedness Subcommittee sometime in December of last year.

According to a summary, which by the way, is not a direct quote of your testimony, but a summary of your testimony, it states as follows, and I will quote:

> I do not agree with the recommendation for an independent agency. One individual must be charged with responsibility.

That is the end of the quote in this summary, which appears to be a summary of your testimony.

General, is that what you feel about this matter?

General MEDARIS. I reached that conclusion after long consideration and study of the problem and I have been given no facts to make me change my mind.

Mr. NATCHER. So you are now of the opinion that one individual should be in charge and that it should not be an independent agency. It should be under the direct control of the Department of Defense. Am I correct?

General MEDARIS. If I may, I would like to expand on my remarks at that time.

Mr. NATCHER. You go right ahead.

General MEDARIS The point there in consideration is where are the resources with which these things are to be carried out? The present resources that are available in this country to carry us forward in the space-science area are in turn almost all involved in some type of military work as well.

Coordination is a difficult matter. Perhaps it is my military background when I say that a single person in command has more virtues in most operating fields than does a lot of cross-coordination.

And the ability to use the resources wisely, as between the military requirements, the space requirements and the science requirements, and to carry them forward in team, using again the resources in common because this is where the work has to be carried out, this is where the resources exist and the teams exist, is going to be quite difficult with divided direction based on the division between science and military purpose.

This was the reason why I made that statement and why I felt that way about it. It is going to be very difficult.

I will say again, as I said initially, the organization can work, but it is going to take very good men working in very close coordination to keep us from having some difficulties by having to always decide which area does the thing, and in having a requirement for coordination interdepartmentally in order to assure us that we have the maximum benefit from science and the military and vice versa, that military work lends its best support to science.

Mr. NATCHER. General, do you have in mind the Manhattan project when you say a one-man organization?

General MEDARIS. No, sir. I am satisfied with the way ARPA has been doing. Roy Johnson tells me what to do and I go about it. I am really happy.

Mr. NATCHER. So you say no independent agency. Then who would head this proposed organization that you have in mind, General?

General MEDARIS. I was talking about having a man who was held responsible for the general field and who was working within the Department of Defense, this because of the necessary coordination in the use of resources between weapons projects and science projects.

And who would head it is up to someone else to decide.

Mr. NATCHER. In other words, in your mind there is a clear line of demarcation and a distinction should be made as between civilian control and military control from the standpoint of this particular organization. Am I correct in that, General?

General MEDARIS. I would assume this in the case of both this as well as our weapons organizations, that they would be subject to civilian control and that they would be civilian operated.

I have at no time proposed that this should be a military operation, controlled and directed by a military man. I have not proposed that. I do not subscribe to that.

Mr. NATCHER. What you do have some difficulty with, in your own mind, apparently is the question of an independent agency being in charge?

General MEDARIS. That is correct, and being outside the Department of Defense, which increases the interdepartmental coordination requirement.

Mr. NATCHER. Now, General, is your research and development based upon military requirements?

General MEDARIS. Our research and development, because of policy and funding and budgetary considerations, has always been based primarily on military requirements This does not mean that we have not done some basic research, always in the hopes it might turn up something to contribute to our principal mission

But this has been the result of an operating method, shall we say, an overall national approach to the problem, rather than what we would like to do.

I think the services generally have felt for many years they should be doing more basic research and not quite as closely limited to that which directly and immediately contributes to weapons systems. I know I feel that way.

Mr. NATCHER. Would it be possible for an organization such as yours to continue to function efficiently under a civilian agency which would permit broader research in purely scientific fields, which have no military benefit at the present time, or value?

General MEDARIS. It would neither be efficient, nor proper, nor easy to do, to have it do so exclusively. My command is not that kind of a command. It has a great many balanced resources. It must maintain the primary responsibility for providing the Army with its most modern weapons in the missile field.

However, I find no difficulty in working for two masters with respect to my projects. I have only one commander in the chain of command. This is simple.

But as far as my projects are concerned, I have no trouble working for two masters. I am doing it at present. It creates no more problem than it does for a big civilian corporation to have contracts with 3 or 4 people. It is the same thing.

Mr. NATCHER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. O'Brien.

Mr. O'BRIEN. I have no questions, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. General, pursuing the same line of questions just a bit further, actually is it your feeling that possibly we may be getting too many committees and too many commissions involved in this overall space and missiles program?

General MEDARIS. It is a possibility, certainly.

Again I say this is going to depend entirely on the quality of the people who work it out and how well they do it.

As I understand the bill, there is a Director who has full authority. He is to be the Director of the Agency and as such does not have to wait for his committee to act on what he is to do.

That being the case, we have the possibility of its reacting rapidly and of coordinating closely and carefully with the Department of Defense.

So there is no reason why it will not work.

Mr. SISK. In reference to the questions by the gentleman from Louisiana a few minutes ago, regarding ARPA, do I understand that your answers were to the effect that ARPA would have full control of contract negotiations, with reference to either the Army, the Navy, or the Air Force, in connection with outer space activities and matters of this type? Is that correct?

General MEDARIS. The way ARPA is operating at present is that they negotiate with us and with other agencies of the Government and outside the Government with respect to carrying out certain projects. And having reached a conclusion that certain projects should be done and having negotiated approximately what the budget is going to be, they send me an order and some money and with that I go to work.

In the progress of that project our technical directors are in close contact continuously and freely with Dr. York and his people in the technical side of ARPA and follow their guidance in carrying it out.

Mr. SISK. What I am attempting to do is to pin down their authority in the field of the letting of contracts. Otherwise, of course, we would have some five agencies possibly letting these contracts.

That is what I was trying to determine. Whether ARPA under its present operation actually has the full control so that they become the guiding agency and we do not have this great spread throughout many agencies in the letting of these contracts.

General MEDARIS. This is correct, they have the control.

Now, the point is, in the matter of letting contracts this can be done in several ways and to date ARPA has assigned its projects in terms of its contracts to existing agencies of the Government which in turn make such subcontracts to support the project as they need to.

They have not yet to date, although they have the authority, I believe, made independent contracts in terms of a regular business contract, a contract obligation document, with civilian companies. They do it much more easily the other way because all of us who are in these fields must have the structure required to handle that kind of contractual action, people to administer those contracts, the negotiators, the legal support for them, and everything else.

We have contracting officers. It is their normal business. They assign it to us and as a part of carrying out of project we let the contract to support it.

We do part of it ourselves and part of it is under contract.

Mr. SISK. At present it is working smoothly?

General MEDARIS. From my standpoint it is working just fine.

Mr. SISK. Now, let me ask you to comment, General, as between the NASA and ARPA. For example, if the pay differential is approved, which I think you are familiar with, I am wondering what your comment might be with reference to its resulting in NASA becoming the controlling agency. Do you have any comment to make on that?

General MEDARIS. I do not see any real basis here for, shall we way, a struggle for power There is an attempt to spell out the different areas of responsibility as between NASA and the Department of Defense. The only difficulty lies in the fact that there is going to be a considerable shadow zone to be resolved, but certainly it does not provide any basis which would lead to a, shall we say, kind of interbureau struggle of who is boss.

Mr. SISK. Let me ask you this. I refer to the pay differential, if it should be approved. Now, is it probable that over a period of time NASA would probably wind up with all the good talent and ARPA, to some extent, would be downgraded?

Now, I am just speculating I am only asking if you have any ideas along that line.

General MEDARIS All I can say is everybody does not chase the almighty dollar. Of course, if it gets to be $50,000, maybe they will, but there is no restriction on the commercial organizations of the country and their pay scales and they have not stolen my people yet and I do not think they will.

Mr. SISK. I appreciate that statement, General, because actually in many instances I think we have some, in fact we have a lot of good devoted people who, let us say, do not put the dollar sign first, and I thank God we do have this kind of people and may we continue to have them.

But, of course, this would become a pressure, I feel, to some extent, on one agency versus the other, if there were extreme differences.

General MEDARIS. ARPA, of course, at present, is not operating as an agency. It is operating as a directorate. It has very few people, apparently adequate for its needs, but it depends upon those of us in the business all over the country to do its work for it.

So in that sense it is not a competitive proposition. I will be perfectly frank with you. I do not know whether under this bill, if this bill is passed, I do not know whether ARPA is still in business or is not. I do not know, sir.

Mr. SISK. Let us change the line of thought just a bit, General I want to ask you a few questions with reference to what your opinion is regarding what we might term slowdown or stoppages in your program that may have affected it in the past.

Let me say this. That we do not desire to engage in recrimination and going back. We want to look ahead, but as these things may have affected the program in the past, I think it is in the interest of this Committee to see that they do not occur in the future.

First, for example, I would like to refer back to Project Orbiter. What, in your opinion, was the effect of your not being able to proceed with Project Orbiter? Will you comment on that, General?

General MEDARIS. Sure. If we want to play Monday morning quarterback, it is real easy to say how the game should have gone on Saturday, but at the time the decision was made between Project Orbiter and Project Vanguard, I am quite certain that the people on the committee who made the recommendation were doing their honest best to make an honest decision.

The fact that it turns out that Orbiter, if continued, would have come to a successful conclusion earlier, is one of these real "iffy" things that really lands into the Monday morning quaterback area.

Mr. SISK. I appreciate we are speculating and using a lot of "ifs", and so on, but I am concerned with statements that have been made by a great many people over some of the reasons for, let us say, one agency being preferred over another in some of the decisions in the hope that we may preclude such decisions in the future.

Now, we have had testimony that you could have launched a satellite, put a satellite in orbit, at least 2 years earlier, or approximately thereabouts, had your team been given the go-ahead.

Now, do you agree with that?

General MEDARIS. Not that long. The earliest that we could have launched a satellite, had we had the project direction and been told to do so, would have been about a year and 3 months, about 15 months earlier than we did launch a satellite. This happens to be a fact that proves itself.

The question of whether it was intended to be that way, or not, is another question.

In other words, I am quite sure that the people who made the decision did not intend to delay the situation, but we were dealing then with the claims of two groups, one of them saying they could do this, and the other saying they could do that.

It turns out that one of them was a little better and knew what they could do and sooner than the other.

We cannot go back and say that this was any question of trying to slow down a program. It was merely a mistake in judgment which everybody is going to make.

There are some tough decisions to be made, Mr. Congressman, and I, for one, will never expect all the decisions to be made right. We don't have this kind of people. We are going to make some mistakes.

Mr. SISK. I appreciate that.

Now, in your testimony before the other body last winter, there were some questions with reference to the type of engines that are needed, the thrust that is required, and so on. In some of your testimony, as I recall, you made a statement to the effect that an engine of something over 200,000 pounds thrust was recommended, but it was turned down.

Are you in a position, or would you want to comment, as to why that was turned down at the time? That was in 1956.

General MEDARIS. The report of the committee that acted on it and recommended to the Secretary of Defense simply said that there is no specific use for this engine demonstrated and therefore we cannot recommend that the money be invested.

Mr. SISK. That brings us down to the reason and the background for the questions.

Now, are there engines of that type now being worked on and in general do the agencies in control of this program, in your estimation, realize the need, even though there may be some question of its specific use at the moment?

General MEDARIS. I think without question that there is now a pretty general realization of the requirement for higher thrust engines. There are some very substantial differences of opinion as to how it should be achieved the earliest.

Again I am not prepared to say what whoever's judgment is followed is going to be infallible. We may make a mistake on this one, too. I don't know.

Mr. SISK. Let me ask, General, and this is up to you whether you want to answer these questions. I realize some of them may get into the realm where you prefer not to answer them.

Are we actually doing research and development work at present on engines, for use in future vehicles or weapons, to the extent that you feel we should?

General MEDARIS. After you added that last phrase, I have to say no.

Mr. SISK. That is exactly the information I am interested in.

General MEDARIS. But this in only my opinion, Mr. Congressman.

Mr. SISK. I appreciate that, General. I respect your opinion.

From the things I have heard in the past, I have the highest respect for your opinion. That is why I am asking for it.

Now, I referred to December, when you appeared before the other body. This, I understand, is not a quote, but a summary, with reference to the overall program, referring to the Jupiter program and Redstone missiles and flight-test vehicles and so on, and in summary of what you say.

"The program is proceeding at optimum speed now. The future roll-on of the program is half the level it should be."

Now, has anything occurred since that time, General, that would cause you to feel differently today?

General MEDARIS. I am sorry, but I cannot put myself in context with that summary. I don't quite get the relationship to my testimony there.

Mr. SISK. As I state, this is not a quote This is merely a summary setting forth generally some of the ideas.

General MEDARIS. Does the summary refer to the Jupiter and Redstone programs?

Mr. SISK. Let me read the entire paragraph:

> The Jupiter program was impeded because there was great debate over whether the Army needed it or not, and this took time The rate of output was limited. Half the amount recommended was approved. The apportionments were—

and here is the quote—

> "always protested by reclamas."

I thought if you wanted to comment on that quote, I would appreciate it, but if you do not, why, I will respect your decision.

General MEDARIS. I will clarify the quote.

Mr. SISK. The paragraph ends here:

> With the inauguration of the Jupiter program and requirement of the Redstone missiles, flight-test vehicles to support the firings of Redstone were accelerated. The program is proceeding at optimum speed now The future "roll-on" of the program is half the level it should be.

I am curious to know whether, in general, you still agree with that.

General MEDARIS. This refers to the production of Redstone missiles for field use and the situation has not changed.

The Army still would like to produce them somewhat faster than we have been able to do.

Mr. SISK. What can this committee, or the Congress, do to take care of that situation? Do you have any recommendations that you would make at this time?

General MEDARIS. Sir, I am afraid this is a matter between us and the Department of Defense I do not know where the question could come in specifically to the Congress without going as deeply into the subject as we all must in trying to decide where each piece of money must be spent and what weapons are to get the benefit of the budgetary support.

I don't know who is right. The Army feels that we would like to have more of them than we are able to produce at the present time. Defense says maybe we don't need any more. Who is right, I don't know.

Mr. SISK. It is my understanding, generally, that it is your opinion that we cannot completely divorce, let us say, satellites from the ballistic missiles, that to divorce them would be to impede the progress of both and that as such they, at least in the immediate future, have to be tied closely together.

General MEDARIS. The missile art has provided the initial earth departure systems, the missile systems by which satellites can be gotten up out of the earth's atmosphere and into orbit.

For the foreseeable future, until somebody finds some other method, this appears to be the one that will have to be used for some considerable years to come.

As long as this is true, anything that is done in the military missile field will have a possibility of contributing to the space field.

So if that contribution is withdrawn, the cost of pure satellites as such, not resting on military requirements for the development of basic thrust hardware, is going to be pretty high if you do them entirely separate.

In fact, I might say it is going to be awfully high.

Mr. SISK. To sum up this question and going back, then, to my first statement, General, do you feel that you are being held up in any way, or are being precluded from proceeding at a rate in the development of the ballistic-missile program as it refers to satellites and all the other things that go along with it?

Now, we referred to the "ifs," if with reference to Orbiter and also in the 1956 test, when I understand certain people came down to see to it that the last stages were not loaded and so on, to make sure that you did not orbit. Now, I want to know if anything is being done today by any agency which is precluding the progress which I think every one of us as Americans is definitely interested in?

General MEDARIS. It is a very large question, Mr. Congressman. I can only answer it this way:

There is nothing being done to inhibit those projects which have been determined to be necessary in the immediate future and of which we have been assigned a proportionate share.

My major concern at the present time continues to be devoted to the next satellite project. I have to say I do not believe that we are looking far enough ahead and starting those things which will be essential to support the kind of things we ought to be doing 5 years from now, the stage ahead of the development of a final weapons system or a final satellite system.

The fundamental developments based on advances in the art which will provide us with more flexible engines, engines of higher efficiency by using more advanced fuels, the very advanced types of guidance systems that will be needed in outer space that are not exactly the same, but can well peel off their missile guidance systems and to which missile guidance systems must contribute greatly, there are a dozen fields of activity that in my opinion are being pursued vigorously which as they are pursued today would not tell us how you will come out in terms of what you will finally do with that product, but if intelligently selected 5 years from now will give you the building blocks by which we will be doing the thing which I think we ought to be doing 5 years from now.

This is one place we have not got into as yet. I think there is every intention of getting into it and I would not have this committee believe that anybody is willfully staying away from it, or anything of that sort.

There are a lot of loose ends to pick up here. We have to look at the position and recognize the fact that, shall we say, 7 or 8 months ago there were not too many people who took this business seriously.

Those of us who did could get qualified as crackpots in a great many places in the country without any effort at all.

All of a sudden people realize that it is a serious business. You cannot pick up all the loose ends and get it all straightened out and then on the track in a few months. It is too big a job.

I hope as rapidly as it can be resolved those things will be going forward. This is my only discontent at the moment, that I would like to be in some things that will lead to the next step in the business.

Mr. SISK. General Medaris, I certainly appreciate that statement on your part. I think the very creation of this committee, the very fact we are sitting here this morning, is because of, let us say, a little revolution in our thinking and a little better understanding that we are in the Buck Rogers age, so to speak, and we are going to have to wake up to that fact.

I know that this committee is desirous of trying to loosen itself from our earthbound tendencies and to be able to make the break. I appreciate the fact that we have men like you who have that vision and that was the point I was making. I think we are desirous of doing the things that will grant to you and others the ability to go forward and plan for 5 to 10 years in the future, to get the necessary hardware and to develop the other things that are necessary without being able to pinpoint today exactly what engine or piece of hardware is going to be used in a military way or in another specific way.

Is that not generally the need that you have?

General MEDARIS. That is right; yes, sir.

I have such confidence in the basic system of government and the philosophy of government of our people, that I believe fundamentally that if the actions of the Congress and committees like this make clear that the people whom they represent are behind this sort of thing, and are willing to support it, then I feel quite sure that our system will produce the kind of results you want.

This is why I am gratified to see this kind of interest.

Mr. SISK. One other thing I would like to have you comment on, General, is this. The day before yesterday Dr. von Braun mentioned the possibility, and as I understand him, what he felt to be the advisability, of putting a man into space some 150 miles. I am sure you are familiar with the statement because there has been some comment here and there about it since yesterday.

It is my understanding, and I am simply quoting the newspapers, because I did not hear the statement, that there was something indicating that, possibly, that was kind of like shooting a woman from a cannon, or something of that kind.

Now, do you feel that has value, or would it be, let us say, more characterizable as a stunt?

General MEDARIS. No, sir; I have not yet and I will not at any time propose to the Government that it spend its funds in support of a project that has no useful purpose or no proper end point to go to.

There are plenty of things to be done that are spectacular that are not stunts, so we don't have to resort to things that are stunts.

The project when it is understood definitely is not a stunt. It is a necessary and essential prerequisite to the careful step-by-step advance of our ability finally to transport people by missile.

I put this even independent of any outer space action in terms of satellites. I foresee a positive requirement for being able to put people on a specific spot in small numbers by missile-borne means.

If we are to do that, this particular experiment is a definite way station on the route we must follow.

Mr. McDonough. Do you believe that will be valuable, General?

General Medaris. I believe it will be very valuable.

Mr. McDonough. That is about the same thing that Dr. von Braun said, but I do not believe it was in Dr. von Braun's mind to interpret this proposal as a stunt.

Dr. von Braun said, if he were given the go-ahead right now he could shoot a man in a capsule in the nose of a rocket 150 miles into space and return him safely.

Then Dr. Dryden came along and said that there were at least 200 such proposals and for the reason that there were 200 such proposals they have not picked any one that they would proceed to put their effort to.

Now, what you have just said is that you want to put a manned missile into space, which would be a valuable thing for us to do, to find out what we can and if it can be successfully operated.

Mr. Sisk. If my colleague will permit me, I will yield back the balance of my time.

The Chairman. General, you will have the opportunity of editing your testimony and elaborating. In connection with that, I would appreciate it if you would elaborate on the uses for peaceful purposes that these activities could bring about, if successful, from the standpoint of the military necessity as well.

So you have the permission to edit your testimony and the Committee would welcome any elaboration on your part that you think is pertinent to the Committee's duties and responsibilities. Mr. Ford.

Mr. Ford. General, may I ask a question or two to clarify some questions that were asked earlier?

Any alleged criticism of the production schedule of Jupiter, in testimony given in December, conceivably may relate to the designation as to whether Jupiter should be put into exclusive production or whether Thor should be put into exclusive production, or whether both should be put into joint production.

Is it fair to say that criticisms of a production schedule would not be the same if you were putting both into production?

General Medaris. That is correct.

Mr. Ford. In other words, sometime in late November or early December, the decision was made to put both into production at a reduced rate for each. Is that correct?

General Medaris. That is correct. Yes, sir.

Mr. Ford. It is also fair to say, I think, that if one, rather than both, had been put into production, obviously you would have needed a bigger rate of production for the 1 rather than for 2.

General Medaris. That is true, Mr. Congressman. The production rate to which I referred in this case, however, was for Redstone, not for Jupiter.

Mr. Ford. It did not relate to Jupiter?

General Medaris. It did not; no, sir.

In my testimony at that time I said almost exactly what you have commented on now, sir, that we recognize the problem of decision, that that decision had just been made before I came before the committee

at that time and this appeared to have resolved itself as far as Jupiter is concerned.

Mr. FORD. Both Jupiter and Thor are now in production. They have been financed and, as I understand it, are on schedule. Is that correct?

General MEDARIS. I can only comment for Jupiter. I never answer for the other fellow's production schedule. Jupiter is on schedule.

Mr. FORD. Which envisages units in the field sometime late in 1958?

General MEDARIS. That is as the Secretary of Defense has so announced and we support his announcement.

Mr. FORD. I think it would be helpful for the record—I am sure you do not have the information here at the present time—but could we have from some source a list of the individuals who made the decision between Orbiter and Vanguard and the date their decision was submitted to the Secretary of Defense?

As I say, you may not have the information here, but if somebody from the Department of Defense could provide that for the record, I think it would be helpful.

General MEDARIS. Mr. Congressman, I will pass that to the Department of Defense. It is appropriate that the Defense Department answer that because all the agencies concerned are under the Defense Department.

(The information above referred to follows:)

The Assistant Secretary of Defense (Research and Development) advised the Secretary of Defense that, as indicated by the studies, a small scientific satellite weighing 5 to 10 pounds could be launched into an orbit about the earth employing an adaptation of existing rocket components. If a prompt decision were made to embark on such a program, he advised, the United States would probably be able to launch and track a satellite of this kind within the period 1957–58. Subsequently, the Secretary of Defense was directed to develop the capability of launching a small scientific satellite by 1958 under the auspices of the International Geophysical Year. Within the Department of Defense the responsibility for coordinating the developmental program and the scientific aspects involved was given to the Assistant Secretary of Defense (Research and Development).

The first Defense task was to develop a specific technical program for the launching vehicle from the several major possibilities afforded by the missile work already in process in the military departments, the problem being that of selecting the alternative with the best chances of success within the period of the International Geophysical Year. To advise on this important selection, an Advisory Group on Special Capabilities was formed, with a membership consisting of 8 outstanding civilian consultants, each having considerable experience in rocketry or associated technical fields, 2 experts recommended by each of the military departments and 2 selected by the Assistant Secretary of Defense (Research and Development), the instructions to the group called for a review of the various satellite plans and programs and a recommendation of an equipment program by August 1, 1955, including suggestions with regard to the governmental and industrial organizations where the different phases of the program might best be carried out and a consideration of the impact of the recommended program on weapons development projects.

The White House announced on July 29, 1955, that plans were going forward for the launching of small unmanned earth satellites as part of the United States participation in the International Geophysical Year. At the same time, the Chairman of the United States National Committee informed the International Committee sponsoring the IGY of the inclusion of these plans in the United States program.

The Advisory Group on Special Capabilities submitted its report to the Assistant Secretary of Defense (Research and Development) early in August 1955. In brief, it recommended the development of a scientific satellite vehicle in 2 phases: (1) An immediate program for achieving a 5- to 10-pound satellite on

orbit during 1958; and (2) a program to launch a satellite vehicle of significantly larger payload and higher orbit at some future date. Noting that on technical grounds the use of the motor of the intercontinental ballistic missile would unquestionably provide the greatest performance margin, the Group disqualified themselves on the question of whether this could be accomplished during the period of the International Geophysical Year because of uncertainties with respect to the degree of interference with the ICBM program that might be tolerated and uncertainties regarding the validity of the current ICBM schedules. The majority of the Group recommended the use of the 3-stage launching vehicle proposed by the Navy; a minority recommended the use of the Redstone missile as the basis of a 4-stage launching vehicle, as proposed by the Army. The Group further recommended that, in any case, studies of the use of an ICBM booster should be pursued as a responsibility of the Air Force.

Through the Research and Development Policy Council, the Assistant Secretary of Defense (Research and Development) sought the advice of the senior civilian and military officials responsible for research and development in the military departments in regard to questions of interservice cooperation and the possibility that the scientific satellite might interfere with weapons programs. After extensive deliberation, including discussion with the Chairman of the Advisory Group on Special Capabilities, the Policy Council recommended, and the Assistant Secretary agreed to, the selection of the Navy proposal for a three-stage launching vehicle based on the Viking and Aerobee-Hi rockets. [The Army members of the Policy Council did not concur in this action.] The Deputy Secretary of Defense approved this proposal and issued a directive on September 9, 1955.

In summary, the Air Force proposals for launching vehicles based on ICBM motors were rejected because of uncertainties regarding the possibility that the weapons-development program might be delayed as a result of combining it with a scientific satellite program. The decision to use the Navy-proposed Viking approach instead of the Army-Navy Redstone proposal was based primarily on the technical recommendations of the Advisory Group on Special Capabilities. To a degree, this technical judgment was founded on the fact that a 3-stage launching vehicle appeared to be inherently less complex than a 4-stage vehicle and, further, that the spin-stabilized second stage involved in the 4-stage proposal had not yet been adequately flight tested. Also, the Army-Navy proposal involved some reliance on the Redstone weapon program and possibly some competition for diversion of Redstone engines intended for weapons.

MEMBERSHIP—SPECIAL CAPABILITIES ADVISORY GROUP, JANUARY 1958

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Dr. Robert W. Buchheim (RAND)
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OFFICES OF THE ASSISTANT SECRETARIES OF DEFENSE,
RESEARCH AND DEVELOPMENT—APPLICATIONS ENGINEERING,
Washington, D. C.

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MARINE CORPS

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Mr. FORD. I would like to pursue what your command relationship is in three specific fields with ARPA at the present time.

Let us take projects that I know your command is working on, the Pershing missile, Nike-Zeus, and the lunar probe projects. The Pershing missile project is strictly a military weapon?

General MEDARIS. That is correct.

Mr. FORD. You get your orders for the prosecution of that project from whom?

General MEDARIS. From the Army Missile Committee, chaired by the Secretary of the Army.

Mr. FORD. ARPA itself has no control over that particular project?

General MEDARIS. It is not within ARPA cognizance.

Mr. FORD. The Nike-Zeus project, from whom do you get your direction in that area?

General MEDARIS. The Nike-Zeus project was in the original assignment by the Secretary of Defense to ARPA.

Mr. Holliday, the Director of Guided Missiles, was the custodian of that authority during the period that ARPA was being formed.

It is my understanding there is a discussion at the present time whether or not that should be taken up by ARPA or whether or not it should remain with Mr. Holliday.

In any case, it is a military project. So far as I am concerned, wherever it is directed in Defense it will be worked in collaboration with the Army Missile Committee under the Secretary of the Army.

Mr. FORD. So as of the moment, ARPA itself does not have control nor does it give you direction in reference to Nike-Zeus.

General MEDARIS. Not at this time; no, sir.

Mr. FORD. Now, the lunar probe projects.

General MEDARIS. That is entirely under ARPA and my directives come directly from ARPA.

Mr. FORD. As I gather the function of this new agency, NASA, you would work with them, for example, on projects like the lunar probes.

General MEDARIS. That is correct, sir.

We would work with and for them; yes, sir.

Mr. FORD. But in the area of a project similar to a Pershing missile, you would still get your direction from the Department of Defense?

General MEDARIS. That would be strictly military and would stay within the Department of Defense; yes, sir.

Mr. FORD. Probably the Nike-Zeus program would fall in the Defense area, would it not?

General MEDARIS. Undoubtedly, it is a weapons system.

Mr. FORD. For the benefit of the committee, could you comment on the military aspects of the satellites?

General MEDARIS. This, of course, has been a very greatly debated point. I rest my own conclusions in two areas:

First of all, I think it is generally recognized that satellites at present offer the best means, the best known means, for reconnaissance under conditions when manned aircraft may be very greatly impeded, if not prevented from carrying out their missions.

This, however, is a responsibility of another service and I will not pursue it further.

The Army's interest in satellites from a military standpoint falls into the general areas of communications as the most efficient communications relay stations that we know could be developed. Weather, which is, of course, of enormous importance to a ground field commander, to know what weather conditions he will confront against a planned operations sequence; and we are quite confident that the science of meteorology can be advanced to the status of an exact

science with considerably longer range capabilities if satellites are used to acquire proper information.

The Army has an interest in space from a military standpoint as an intermediate part of the transit route, shall we say, in our logistics problems in the transfer of personnel and supplies.

In the scattered, isolated, and fast-moving battlefield of the future, the ability to transport very valuable and badly needed supplies to exact areas without the capability of their being stopped will become of tremendous importance in my opinion.

Missiles provide that resource. The missiles themselves, of course, go part of the way through space and the reentry problem, which is part of the space problem, is in that field also.

This is the Army's interest.

From a personal standpoint I have the unhappy conviction that unless something happens to change the basic psychological makeup of man he will find some means to generate an argument in any place that he can handle himself and can exist; and it is entirely feasible and possible in my mind that we get into a position where the military value of the satellite even for relatively passive purposes, as I have mentioned, becomes recognized immediately the question comes how can we stop them or get them out of there. Maybe we find the best way to do that is to get up there with them and chase them around a bit, which appears to be about the only way you can really counteract a satellite, to be able to take knowledgeable action against it, which means a manned satellite of some kind.

You get in a fuss and you send somebody up to protect your satellite and the first thing you know you have a first-class war on your hands

Mr. FORD. I gather from your comment that there is feasibility to an antisatellite satellite weapon.

General MEDARIS. Yes, we think so. We have several concepts of what such weapon should be. It has its problems.

Inevitably it leads you to the conclusion that there is an easier way to do it if you could send a man along. This is one of the reasons why I follow this chain of thinking, myself.

Mr. FORD. Are we working on feasibility studies on an antisatellite satellite project?

General MEDARIS. I might say as far as feasibility studies are concerned, I have a small corner of my shop that does nothing but work in any direction we think is profitable.

I think the answer to your question in that area is definitely yes.

Mr. FORD. In reference to the bill, General Medaris, a provision on page 3 says:

> No more than 8 of the members of the Board shall be designated from appropriate departments or agencies of the Government of the United States, including at least 1 who shall be from the Department of Defense.

As you know, the total membership of the Board is to be not more than 17; 8 from the Government, including at least 1 from the Department of Defense, and the remainder from outside the Government.

Do you feel that one from the Department of Defense is adequate to represent the views of the military on such a board?

General MEDARIS. In view of the fact that the Director of this agency is the operating authority and the Board is advisory, the real problem from the standpoint of representation is in the Department of

Defense. There comes this problem of coordination that I have mentioned. Provided he is adequately armed with the facts by supporting services and entities of the Department of Defense, one man is enough to bring that to their attention.

Mr. FORD. Do you feel it would be better if there were a provision to pin down the fact that there should be 3, for example, 1 representing each of the 3 services?

General MEDARIS. I think that would just carry some of these lovely arguments further.

Mr. FORD. Do you feel that the person from the Department of Defense should be a civilian or a military man?

General MEDARIS. I do not think it makes a whole lot of difference, Mr. Congressman. Probably in view of the fact that the Department of Defense is civilian directed and we subscribe to that kind of direction, it would perhaps be better if it were civilian.

The major problem is the question of the quality of the people that are put on this Board, not what kind of suits they wear or where they come from.

Mr. FORD. I gather, then, that you feel rather strongly it would perpetuate some of the alleged interservice rivalries if the Congress in such legislation wrote into the bill that there should be 3, 1 from each service, on such a board.

General MEDARIS. Congress would almost be forced to make it 4, then, 1 from each service and 1 from the Department of Defense.

Mr. FORD. It might even be five with the Marine Corps.

Mr. BROOKS. With the Coast Guard it would make it six.

General MEDARIS. I am afraid this is a matter for the determination of the Congress.

The only thing I can say is that I feel again the quality of the people put on the Board is the real matter and there must be a means for introducing into the Board's discussions the knowledge of the current planning and the current requirements of the Department of Defense agencies and the departments of the military services with respect to their need for their own weapons and the impingement of that need on the resources that could possibly be used by this agency.

Mr. FORD. Earlier you indicated that you had called on NACA for certain work in their facilities and with their personnel.

As you visualize this new agency, the process might well be reversed, they would be calling on you rather than vice versa?

General MEDARIS. I would presume so.

Mr. FORD. Do you think that reversal of procedure would have any adverse impact on your working relationships?

General MEDARIS. I have to reduce these things to a rather simple premise, myself.

We have resources. We have capability. We want to use them in the national interest. To do so we require intelligent direction and the provision of funds. Where that direction and those funds come from is not important, provided it is intelligent direction, provided we can get decisions, provided our resources are utilized in the national interest.

Mr. FORD. So far, your relationships with NACA have been satisfactory?

General MEDARIS. They have always been satisfactory. Yes, sir.

Mr. FORD. That is all, Mr. Chairman.

The CHAIRMAN. General, Secretary Brucker reorganized the four major research and development units under your command. Will you put in the record, without my asking you the questions, just what the effect of it was, what is under your command at Huntsville and the missile testing center, Redstone, and so forth; also, what authority you have for straight action rather than going through a number of difficulties which have existed heretofore, which are unnecessary to go back on because we have to look to the present and the future, at least as far as I am concerned.

Do you have in mind what I want?

General MEDARIS. Yes, sir; I think I know what you want, and we will put that in the record.

(The material furnished was classified.)

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. General, we are glad to have you here. Your testimony brings up the point of how we should legislate in order to keep——

The CHAIRMAN. Will you pardon me a minute. I see General Gavin is here.

General, would it be agreeable for you to appear at 2:30. We will have to recess because the House will be in session. Will that be agreeable to you, General?

General GAVIN. I certainly can, although I have an appointment tonight I must make and fly back South.

The CHAIRMAN. Let us make it 2 o'clock. Will that be agreeable to you?

General GAVIN. That is fine. I will be right here, sir.

The CHAIRMAN. Now, you gentlemen continue with General Medaris.

Mr. FULTON. The question comes up how Congress can frame legislation so that we can keep the advantage of the agencies that are already in being and likewise add further facilities and maybe policy direction without limitation.

So that in the act on page 2, the bill that has been introduced by Congressman McCormack, and some of the rest of us. The one we are referring to is H. R. 11881. On line 4, it states:

> That the Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States, except insofar as such activities may be peculiar to, or primarily associated with, weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense.

Does that language, in its present framing of the words, restrict your operations or can you live with that language?

General MEDARIS. I am afraid, Mr. Congressman, it may be a question of the interpretation of the language rather than the language itself.

If the language is interpreted to hold a very tight rein on the military departments and the Department of Defense, with respect to basic and applied research projects, which may yield things beneficial to the military, it can be a detriment, if it is very tightly and restrictively interpreted.

As I mentioned before, one of our objectives and one of our hopes has been to get more latitude in the area of working toward the

translation, toward the penetration of frontiers, that we believe may have military significance.

And the second step of translating new knowledge into practical form in terms other than a final weapons system, in terms of those things which will contribute a final weapons system, I would hate to see that go backward.

It has been bad enough and we hope it will be better. So it will rest entirely on how restrictively the language is interpreted.

Mr. FULTON. In your statement on page 2, you said:

> The United States Ordnance Missile Command is without any limitations as to whether either the end items produced or the knowledge gained are to be devoted to sole use of one military service.

I think that is a good statement, but the question that I am bringing up now is. Should you be limited in your particular programing simply to activities that may be peculiar to or primarily associated with weapons systems, or military operations?

My feeling is that you should not, that you should have a broader field of basic research which might be the foundation stones for later systems.

General MEDARIS. I agree, sir, I feel that we should have, that the services should have a broader mission in the area of missile research.

Mr. FULTON. As a matter of fact, do you agree with Dr. von Braun that the fact that the budgeting requirements have almost forced you to look for a military end item result has caused an impeding of the development programs?

General MEDARIS. I feel so, and I have so expressed it in the past.

Our weapons programs actually would be more efficient and would be cheaper if we could get further into the area of the application of the product of research before we committed ourselves to a definite weapons system.

In the long run, I do not think we would spend any more money. There is a gap period during which there would be some duplication or some additional expenditure to pick up this intermediate area of applied research.

But once we got by that we would spend no more money and perhaps less, because we would have a clear knowledge of what we wanted in the weapons system, before we committed ourselves to final design.

Mr. FULTON. On page 16 of the McCormack bill, there is a Section 8, Transfer of Related Functions. This section refers, of course, to the transfer of functions to the new space agency.

It states that for a period of 3 years after the effective date of the proposed act, the space agency, with the concurrence of the head of the department, or the agency concerned, and with the approval of the President, may transfer to itself any functions, including powers, duties, activities, facilities, and parts of functions of such department or agency, or of any officer or organizational entity thereof which relate primarily to the functions of the space agency.

Would you retain in the proposed legislation, then, for 3 years, the requirement that a particular agency, such as yours, should consent to the transfer of the facilities or functions to the new space agency?

General MEDARIS. That is one solution, but it, of course, implies that the people who would be operating the new space agency might not be trusted to examine with clarity and objectivity the conse-

quences of dividing and splitting organized and functioning groups.

Mr. FULTON. If I could refer your attention to the fact, it says that for a period of 3 years after the effective date of the act, this consent is required. Does that in any way alter your opinion?

That is a transitional period, it would seem to me during which it would require the consent of the agency concerned before facilities, functions, or personnel were transferred to the space agency without its consent.

General MEDARIS. Well, as to that 3 years—maybe I should not say this—but if for that 3 years I have the present Secretary of the Army, I have no fear.

Mr. FULTON. Fine. On page 8 of the proposed legislation here is something that might strike closer to your financial policy and your pocket in your type of agency.

At the bottom of the page on line 20, it says:

> In addition to authority to use provided by this subsection and, notwithstanding any other provision of law, any governmental agency or component thereof is authorized to transfer to the agency, without reimbursement, supplies, equipment, aircraft, missiles, space vehicles, and related parts other than administrative supplies or equipment.

I would like to ask one question on that: Would it not hurt your military program development to have to take steps without reimbursement to provide materials for the so-called new and expanded space program?

Should we not say as a matter of equity that an agency such as yours, that has been operating these programs so far, should be fully reimbursed in its budget for the current value of any facilities or items that are transferred to the new space agency?

Is that not just robbing Peter to pay Paul?

General MEDARIS. Again it is a question of how it is handled, Mr. Congressman. They are permissive in nature, they are not mandatory apparently from the language and if they are carefully evaluated and if that authority is resorted to only in those cases where there may be some facilities—I don't know of any in my complex—that could be transferred without a loss to the military program, in other words, they are surplus to the military and are required only for the kind of thing the agency is going to do and which could not be done by the group which presently has the facilities and if the transfer of missiles and hardware were confined to those which inevitably turn up in very small quantities as a byproduct of a development program and therefore would not impede the military program by making them available without reimbursement, then it is a sound and appropriate way to do it.

On the other hand, if it becomes the basis for straight out piracy, why, we are in trouble. It is just that simple.

Without some such authority, of course, we would be in difficulty even if we have an extra test missile left over from a test program that has come to a more rapid conclusion than it was expected to and we wanted to use that on behalf of the space agency to do something for them we could not do so without being paid back, without some such provision.

So again it comes back to the intelligence with which it is administered.

Mr. FULTON. As to the continuation of ARPA, I would like to point out to you that in the President's message of April 1, he said:

> I am requesting the Department of Defense and the National Advisory Committee for Aeronautics to review pertinent programs of the Department and to recommend to me those which should be placed under the direction of the new agency. It is contemplated that the Department of Defense will continue to be responsible for space activities peculiar to or primarily associated with military weapons systems and military operations. Responsibility for other programs is to be assumed by the new agency.

So that, obviously, it would seem that ARPA is to be continued for military-type programs.

General MEDARIS. I don't know. I frankly don't know. I don't have any idea.

Mr. FULTON. You have brought up a question of whether the whole space program should be centralized under one agency. When we have the military policy integrated under an arrangement where one of the members of the new NASA is a military man, it would seem to me that the overall space policy would be set by NASA.

Now, that same question came up in 1928 in Russia and Tupelov recommended to Stalin that the research and development in Russia be decentralized.

If we in the United States adopt this new NASA agency, are we not going opposite Russia, because at present Russia now has 775 technical institutes operating on research and development?

The question is: Should we keep you people, that have been operating on your programs, decentralized, or should we in Congress prepare legislation which will pretty much centralize policy, both civilian and military, under an overall national space agency?

General MEDARIS. There is quite a difference between a centralization of policy and a centralization of activities. Centralization of policy appears to be rather essential to decisiveness, to getting of decisions as they are required.

I would certainly not be in favor of any series of actions which resulted in centralizing operations in the research and space fields, or any other fields, which purported to bring all of those into one entity of operation.

Mr. FULTON. But you would not object to an overall civilian-dominated space agency which sets a national space exploration operation policy, would you?

General MEDARIS. I could not validly do so because they finally are also, I would presume, subject to the national policy decisions stemming from the President and the National Security Council and would be expected to be responsive to the national policy.

As long as this is the case, the subordinate making of active policy is bound to be in coherent fashion related to the national policy.

Mr. FULTON. Do you favor the production of the million-pound-thrust engine as a crash program?

General MEDARIS. I am still convinced of the validity of my previous remarks that we have to have available a well-tested capability of a minimum of million pounds takeoff thrust, either by a combination of multiplex engines or by a single engine.

I lean rather to the combination rather than the single size, myself.

Mr. FULTON. How much will that kind of program cost?

General MEDARIS. Historically, the development of an engine up to the point of having fully tested prototypes and development-type

prototypes will cost somewhere in the vicinity of $75 million in that size, I would suspect.

Mr. FULTON. So to date there has been $500,000 authorized for the study of such a program and if it continues at the same rate it will take, on your figures, 150 years to develop such a program?

General MEDARIS. This, of course, would not be responsive. If it is to be done at all, it has to come out of that and get moving.

Mr. FULTON. That is what I am trying to come up with. So you think it is an urgent program and we should immediately have funds on a level that can get a good study going and get the procedure started?

General MEDARIS. I certainly do.

Mr. FULTON. So it would run in an area of fifteen to twenty-five million dollars that should be provided by Congress immediately?

General MEDARIS. Although this program has not been costed out, because we have no sponsored program of our own at the present time, but I would presume that the first year's operations, if this were to be done as a matter of urgency for any one engine, would have to run in the bracket from fifteen to twenty-five million dollars.

Mr. FULTON. As a matter of defense we will have this TLM-18, telemetry antenna developed, and we have only five of them in use now.

This is the United States Air Force automatic tracking telemetry antenna, used to track ballistic missiles, which is designated TLM-18.

Why do we not start on a very much expanded program of TLM-18 and scatter them around bases to see where the rockets are coming from before they come into the vicinity of the United States? Is that not an urgent requirement for the expansion of these telemetry antennas so that they may be used as pickets against rockets and ICBM's that might be launched?

General MEDARIS. This program is going forward under the antimissile missile program.

Mr. FULTON. Is it going forward quickly enough, or should we have a crash program on it?

General MEDARIS. I believe, Mr. Congressman, that the antimissile missile system should go forward at the absolutely optimum rate. I am opposed to the word "crash" program because there is a rate which will yield the fastest and best results which does not put you into the panic area.

Too many times when we talk about a so-called crash program we just mean to jump up and down faster and get a little more confused.

Mr. FULTON. But it should be done with urgency?

General MEDARIS. With maximum urgency and consistent with a sound program.

Mr. FULTON. Suppose you had the adequate funds and the command to go, full authorization, adequate facilities and equipment, and the choice of all available scientific and research personnel—that is an optimum situation—and were given the go-ahead, how soon could you take a target shot at the moon?

General MEDARIS. If I have all those things, I am going to do it pretty quick.

Mr. FULTON. How soon?

General MEDARIS. I am sorry, but you are asking me to violate a basic matter of my own personal feeling of what is right.

To focus the attention of the whole mass of people, press, and everything else, on a specific date for one of these occurrences, throws a handicap into the project itself that we can ill support.

I do not think it is wise and I have consistently declined to answer that question and I would like to have the privilege of declining it now.

Mr. FULTON. You see, on the X-15 the Air Force has said it will take them 2 to 3 years. Your own people have said that you can do a capsulized shot with a man in it quicker than that—about half as quick, in a year.

General MEDARIS. That is right.

Mr. FULTON. Why do you not make some comment, then, as to the time on this moon shot?

General MEDARIS. I will make only one. That is that my presently authorized satellite programs will be completed before April of next year.

Mr. FULTON. Thank you very much.

And the moon is one of them?

General MEDARIS. Yes, sir; this has been announced.

Mr. MCDONOUGH. General Medaris, I appreciate your appearance here today and I think you have done a very excellent job in informing the committee of the present status of our satellite missile and rocket program.

I agree with you on withholding any specific date on this so-called propaganda idea of shooting at the moon.

Mr. FULTON. Except for April 1959.

Mr. MCDONOUGH. In your opinion, do we have the basic research or the basic scientific data and the manpower in the United States to match Russia?

General MEDARIS. I have stated rather consistently, Mr. Congressman, that in my opinion, we do have as much and as good and as advanced information in all these fields as anyone else in the world has. I believe that intelligently directed, so that the efforts of the various teams of capable people in this country are consistently held into their most appropriate channel, so that each can be consistently working without interruptions or delays in a field appropriate to their knowledge and talent, that we do have what we need in the way of people, brains, capability, to match anybody.

Mr. MCDONOUGH. Do you mean industrial know-how in the civilian components as well as in the military components?

General MEDARIS. I am taking the across-the-board resources of the United States, the development teams, scientific teams, laboratories, university resources, the whole box together.

If all of the people that are available with sound knowledge, background capability, and experience in this field are properly utilized——

Mr. MCDONOUGH. Marshaled and coordinated, you mean?

General MEDARIS. Marshaled and coordinated. The major problem is to assure that each existing team and resource has a job to do that they can get on down the road with, are not concerned about what is going to happen next, as to whether they will be out of a job when this is done so they don't kind of timorously come to the tail end of it.

Mr. MCDONOUGH. Do you think the Aeronautics and Space Agency proposed in this legislation will help to coordinate that manpower in both the civilian component and military components?

General MEDARIS. It requires further coordination between that Agency and the Department of Defense to effect it.

Mr. McDONOUGH. In your opinion, is space more of a civilian advantage for exploration, or a military advantage?

General MEDARIS. I think it is a civilian advantage and a military necessity. I do not think it would be possible to put an outright priority on either direction.

Mr. McDONOUGH. Of course, it is difficult to anticipate what it will develop into, but at the present time should the emphasis be on military or civilian exploration?

General MEDARIS. At the present time the emphasis is properly on space science. You can interpret this as civilian or any way you like, but the present emphasis must be in the direction of finding out what we possibly can about the environment and about the means for handling that environment.

Mr. McDONOUGH. On that particular subject, do you think we have, at the present time, as much on such matters as the Soviet Union?

General MEDARIS. I do.

Mr. McDONOUGH. And that we can continue to acquire knowledge just as rapidly as they can on that subject?

General MEDARIS. I see no reason why we should not.

Mr. McDONOUGH. Now, if we, in the process of developing this space exploration, come to some sort of international understanding or treaty with the Soviet Union and the other nations of the world that space shall be used for peaceful purposes, what position will that put your military development and research into?

General MEDARIS. Of course, first of all, this is like any other approach to the question of disarmament because it is disarmament before the fact rather than after the fact, but it is the same thing.

First of all, as a military man and therefore charged with some sense of responsibility for the Nation's defense, I have to urge that any such agreement should be adequately backed up by proper and complete guaranties against its violation.

Assuming that such were present, this would still not diminish, in my opinion, the advisability of pushing further into the knowledge of space and how to handle it, to the ability to use it to man's ends.

Mr. McDONOUGH. By the military?

General MEDARIS. I believe that the military has an adequate background of being able and willing to cooperate with and benefit the peaceful activities of the country as well as the military.

May I draw a parallel, that in the winning of the West, the military had a very significant part.

Mr. McDONOUGH. You mean to fight off the Indians and let the white man move in?

General MEDARIS. This was only part of it. Some of the transportation that went into the West was based on military necessity. Yet the end result of it was the opening of a tremendous new frontier and land empire to the United States.

Mr. McDONOUGH. Do you look upon space now, since Russia did not challenge us and we did not challenge them on releasing satellites into this common highway in the universe, do you look upon space now as in the same position as the freedom of the seas that is enjoyed by all nations?

General MEDARIS. I think this is a question that had better go to some lawyers. It gets a little bit involved for me, sir.

Mr. McDONOUGH. I realize that, I am not asking for a legal opinion, but I am pointing to the fact that we are not challenged on it, that it is open territory.

General MEDARIS. This might be true or it might be there is no challenge raised because there is no effective means of enforcing the challenge.

Mr. McDONOUGH. For instance, we do have freedom of the seas now. We have to maintain that freedom by resisting any nation that may challenge our position on the seas.

General MEDARIS. That is right.

Mr. McDONOUGH. Therefore, the military comes into position.

Do you think our military position in space, regardless of an international understanding or agreement, will still require military implementation and manpower to resist any nation that may challenge our position there?

General MEDARIS. I think that no international position can ever historically be considered firm unless the capability exists of supporting and enforcing your position by military means.

Mr. McDONOUGH. Now, insofar as the agency is concerned, do you think that we ought to make a straight line command on this situation? I am not talking now about reorganization of the Defense Department, but on space development. Ought it to be through a single line of coordination rather than two agencies? That is, aeronautics and astronautics?

General MEDARIS. As there is a very definite alliance between missiles and space operations, there is also a very definite alliance between aeronautics and astronautics.

There is an interreliance and interrelationship. Certainly aeronautics and astronautics should not be marked out as separate areas. If there is to be a civilian agency controlling the scientific effort of the United States in the space area, there must remain some responsibility within the Department of Defense for its military requirements.

It would be highly impractical and unwise in my own personal opinion to concentrate all outside the Defense Department.

Mr. McDONOUGH. That is all, Mr. Chairman.

Mr. BROOKS (presiding). Do you have a question you want to ask?

Mr. FULTON. With the new Russian rocket they have just announced, called Molnitsa, they have put a dog into space 132 miles. Why is it going to take us in the United States so long to put a manned vehicle or rocket, such as Dr. von Braun spoke about into space 150 miles?

Why should it take us a year, when the Russians just this week announced they have a dog they have sent up and returned very happily?

General MEDARIS. I could perhaps answer your question if I knew when they started on this project. I am quite sure they did not start 60 days ago on that project.

I would have to go back and quote what I think is one of the more outstanding remarks of World War II when General Knudsen, in attempting to demonstrate to the Congress why tanks could not be had flowing out a day after the contract was let, finally in exasperation

said, "We have the best obstetricians and the best hospitals in the country, but, by gosh, it still takes 9 months."

Mr. BROOKS. General, you say that everything is going fine under your command and you are satisfied with the progress you have made. Now, I have heard statements made that things are not so satisfactory. How have you ironed out all your differences and your problems so that there is nothing wrong?

General MEDARIS. I believe that within my command we have no problems that we cannot solve. If we ever have no problems, we will dissolve the command.

Mr. BROOKS. Will you say that again?

General MEDARIS. I said within my command we have no problems we cannot solve—within the command. Whenever the command has no problems we should dissolve the command.

Mr. BROOKS. You are satisfied, though, with the progress you are making in resolving your problems and you have no differences there that are brought to your attention and are subject to conclusions?

General MEDARIS. I am afraid I don't understand. Are you dealing with matters within the command among the agencies?

Mr. BROOKS. Yes; and the lack of progress. We have read different criticisms about lack of progress in the past. I, myself, think you are a very able officer and the country is fortunate to have you. But, aside from that, I have read of some criticism and the committee will probably get some criticisms, too.

General MEDARIS. I don't think we will ever have the time when somebody will not have the feeling that they can sharpshoot about something that we are doing. I will never say that I am satisfied. I am never quite satisfied.

We are making sound progress and continue on schedule in the more important areas that are assigned to my charge. We have some points that I am not satisfied with, if I take all the programs that are under command jurisdiction.

We go about curing those. We have some things that we would like assigned to us that we have not had assigned to us.

Mr. BROOKS. What is that?

General MEDARIS. We hope to have those assigned to us as fast as they can be resolved. These are in the areas I have discussed, of applied research and a few additional——

Mr. BROOKS. Who is holding that up?

General MEDARIS. I would not say it is being held up, Mr. Congressman.

Mr. BROOKS. Whose failure is it to let it go through?

General MEDARIS. There is no failure. These things must have their consideration.

There are probably, as you were told yesterday, undoubtedly thousands of schemes that have been presented in the light of recent developments. We try to present ours in a sound——

Mr. BROOKS. All we are asking of you is a frank statement. Specifically, what do you think of some of the references by General Gavin, for instance?

General MEDARIS. To our programs?

Mr. BROOKS. Yes

General MEDARIS. I do not particularly know what references you might have. I think it is the general position of informed military

personnel that the translation of new concepts into sufficient force in being in the Army is not what we would like to have it, where we believe it should be.

This applies across the board, in the missile field as well as others.

If that is what you refer to, why, none of us are satisfied.

Mr. BROOKS. Of course, I know you were not satisfied when the order came down, on September 20, 1956, to hold up the development of the Redstone-Jupiter rocket. I assume you protested then?

General MEDARIS. Very much so.

Mr. BROOKS. But that has thrown us back about how far in the development of the program?

General MEDARIS. I do not think that really wound up holding us back at all. I went through this era sometime back and by just keeping our head down and trying to make up for delays by extraordinary efforts and insistent reclamas, we managed to stave off any delay until the decision was finally made to field both the Jupiter and the Redstone.

Mr. BROOKS. In the testimony, it was mentioned that we were delayed a year and we would have had the satellite up a year before Russia.

General MEDARIS. If you were referring to the satellite, that is a different matter. I was referring to the Jupiter program and weapon program.

Mr. BROOKS. This is the satellite.

General MEDARIS. It is a Redstone booster and does not depend on Jupiter hardware.

Mr. BROOKS. The basic hardware is Redstone and the Jupiter is attached to it.

General MEDARIS. No, sir.

Mr. BROOKS. Section 2 or 3?

General MEDARIS. No, sir; there is no part of it associated with the Jupiter weapon system. The reason it was designated Jupiter C is because it was a test vehicle in the Jupiter program, a special test vehicle in the Jupiter program for reentry test.

None of the hardware in the Jupiter C, which was the satellite carrier, is the same as hardware in the Jupiter missile.

Mr. BROOKS. Would you call Explorer No. 2 a success or a failure?

General MEDARIS. Explorer No. 2 was a failure. It did not get into orbit and that was the purpose of the exercise.

Mr. BROOKS I am asking you how far it did get. I assume it was pretty close to orbit

General MEDARIS. Well, it lacked the fourth stage, but the difference in velocity between the third and fourth stage is tremendous because you are already in the atmosphere, you are a vacuum trajectory, you are in a light article, you get a tremendous acceleration in velocity in the last stage.

Mr. BROOKS. The trouble was with the last stage?

General MEDARIS. That is right. The last stage did not ignite.

Mr. BROOKS. Was that Redstone?

General MEDARIS. No, sir. These were special clusters of solid rockets that were designed for the Jupiter-C vehicle. That was the first ignition failure we had

Mr. FULTON. Before you leave your question, you have asked him the question: What project would you like to have assigned to you specifically?

You have been asked that question and there has been no answer to it.

Mr. BROOKS. I asked him the question. I did not push him because I know the general is fair and is anxious to give us all the information available.

General MEDARIS. I feel somewhat reluctant to answer that question because we are presenting the projects that we believe we can do.

We are presenting them as thoroughly as we know how. We have not been turned down on any of them. There has not yet been time to evaluate the ones to which I refer, to evaluate them properly.

Mr. FULTON. You see, we have confidence in your organization and since this committee, through its members, seems to indicate they want you to go ahead much faster and to have every facility, we would like to have you tell us how we can accommodate you.

I do not want to be in a position where you would be saying this is as fast as the Army Ordnance can march and that is as fast as it is going.

General MEDARIS. I am not saying that. We are asking for approval of an additional space science program with some military application, extending further ahead than that one we now have, so that we can look further into the future.

Mr. FULTON. Could you outline that last statement in the record at this point, with the chairman's permission, at a later time?

Mr. BROOKS. If you could elaborate on that in the record, it will be fine.

General MEDARIS. I believe, sir, it should be submitted under classified cover.

(The material furnished is classified.)

Mr. BROOKS. I recognize counsel, Mr. Feldman.

Mr. FELDMAN. General, before this you said you had some experience with the NACA and that that experience was satisfactory.

I wonder if you can tell us whether you start by submitting a project directly to NACA, to its Director, or go to a committee?

General MEDARIS. As I mentioned, the projects that we have asked NACA to do for us have been quite minor and involved the use of some of their specialized facilities.

In those cases we were able to make the arrangements directly with the laboratory, or the agency of NACA, concerned. We don't have to go to headquarters for those.

Mr. FELDMAN. Are you acquainted with the fact that the NACA has a large number of committees and subcommittees?

General MEDARIS. I am.

Mr. FELDMAN. And that many projects go to these various committees and stay there a long time?

General MEDARIS. I have not in my work been subject to the area in which these projects are effective and, therefore, it has not happened to me and I just don't know about it.

This is the point——

Mr. FELDMAN. I wondered whether you had any knowledge on that point?

General MEDARIS. No, I do not.

Mr. FELDMAN. Now, what is your opinion, General, on the merits of competitive programs within the Military Establishment?

General MEDARIS. I think they must be gone at quite selectively. There are many places where competitive programs are not warranted, but there are other places where I believe they are warranted. And in two degrees:

There are places where a full competitive program, that is two competitive systems, may be warranted.

There are more places where competitive parts systems are justified.

For my own part, the type of analysis that I apply to this kind of area has to do with two things:

First of all, it has to do with the degree of certainty with respect to actual conclusion on one dependable line of approach.

Secondly, with the degree of urgency and the importance that could be attached to a partial failure or considerable delay.

These are the things that must be assessed. If you are in an area where there is valid doubt as to the success of a single line of approach, where there is not absolute assurance, and you have a mandatory time scale that will prejudice the security of the country if it is not met, then definitely the competitive approach is justified.

Mr. FELDMAN. Do you feel that the satellite program in support of the IGY should be divorced from our military program?

General MEDARIS. If it had been wholly divorced we would not have two Explorers up there now. In other words, it was supported by military hardware, this is the point.

Mr. FELDMAN. That was precisely the point I was trying to bring out.

General MEDARIS. I think I can state my feeling again in very concise terms on this. If you try to place the entire space exploration program independent of military support, independent from military programs, you are going to pay an awfully big bill. It only makes sense that those elements of military programs which result in the development of a type of hardware that can contribute to space exploration should be used for that purpose.

And you should not have to pay development costs twice just because this one had a military tag on it. You have paid that already, let us use it.

Of course, we kind of like to use the hardware that we buy. We do not like to give them to someone else to use them.

Mr. FELDMAN. In that connection, scientist Lloyd Berkner is quoted as having said:

> Pure scientific problems involved are complex and their solution can be best achieved under civil auspices closely related to the academic atmosphere because they transcend the normal limits of military technology.

What is your opinion of this statement?

General MEDARIS. I do not think he realizes the limits of our technology. I think he is downgrading us a little bit.

Mr. FELDMAN. Would you say that the horizons are about the same as they are in space?

General MEDARIS. I certainly think so.

Mr. FELDMAN. What are the scientific values of an unmanned space program?

General MEDARIS. First of all, even if we are not going to use space as a new frontier of travel and exploration, there are definite values to be applied to our own living conditions and our knowledge of the conditions that we must meet here on earth by having a much greater

knowledge of the whole characteristics of all those parts of the solar system which have an influence on the behavior of the earth.

To this end, or in that area, we can direct a specific application. We can say, for example, that if we can find out the exact pattern of the so-called space area around the earth and out at least as far as the earth's own satellite, the moon, that we will be able to better interpret and know what the longer range trends of man's environments are going to be.

We will know more about the whole problem of the influence of the race and energies that exist in outer space.

It is not really a vacuum; there is a lot of stuff out there, it is not just air. It all has an influence on our atmosphere and our environment.

The true magnetic shape of the earth has a very definite influence on our communications problems and communications reliability. This can only be determined by space experiments.

There are certain functions made, but so far we have found that where we have explored the deductions, shall we say, have had to be refined at the very least.

Beyond that, however, we come to the point that if man is not to stand still and standing still means going backward, then for any knowledge we can acquire he should acquire, and this is for its own sake, because we are not smart enough to see where we are going with all of these things.

History is full of examples where things were stumbled on as basic principles and the man who did it had no more idea what it meant than you can imagine even as late as 50 years afterward somebody came along and found that that was a basic requirement to something that was needed at that time.

But it only came about because somebody was curious. So I feel that wherever there is the possibility of acquiring knowledge, it should be accepted as a challenge to a man to find go out.

Mr. FELDMAN. I think a very apt example would be what Goddard had to go through when he developed the missile.

General MEDARIS. That is right.

Mr. FELDMAN. Now, can you tell us the achievements of the United States Army Ordnance Missile Command? I mean specifically. You can review some of the important ones, in any event.

General MEDARIS. The organizations which constitute the United States Army Ordnance Missile Command have historically, going back to the years even before World War II, been responsible for either the direct development or the direction of development and conversion to weapons systems and fielding of all of the missile systems that the Army now uses and those which are coming on.

I think the series of names is well known to everybody. They range all the way from short-range tactical missiles through the Corporal and Redstone into the longer range field.

They also have been responsible for a great deal of fundamental investigation and development in the area of solid propellents.

The Jet Propulsion Laboratory and the organizations at Redstone under the cognizance of the command, inhouse laboratory at Redstone Arsenal, I should say, have contributed a major share of the basic advances in solid propellents, in case bonded propellents and in the composite propellent field.

They were responsible for the earliest successful JATO, jet-assisted takeoff, both also for the Air Force later taken over and developed by others to a greater extent.

The primary investigations and results that have been achieved in the air defense system through the whole generation of Nikes have been under the sponsorship, direction, and guidance of the then Redstone Arsenal, now the Army Rocket and Guided Missile Agency.

The programs have been conducted, some by industry and some inhouse, but always against the background of existing technical knowledge, and a fine group of highly qualified people to guide and influence and make these programs that they might achieve the most useful ends.

I could actually put in pages if we were to go into the scientific area, of the new things that have come out.

Mr. FELDMAN. Could you do that for the record when you edit the record?

(The material furnished is classified.)

General MEDARIS. We can certainly give you a representative sample of these things. One that I would particularly like to mention is that the first successful missile inertial guidance system in the country was flown as the complete result of the development work of Dr. von Braun's group and was flown on board the Redstone 5 years ago.

This is not thoroughly understood by everybody.

Mr. FELDMAN. I think it is a very imposing list of achievements.

I think Dr. von Braun, the other day, suggested using missiles for troop movement. That would be pretty costly. Would that be justified, or would it be feasible?

General MEDARIS. I think this is maybe a misconception. If we take the figures well known to the Congress with respect to the cost of acquiring, maintaining airplanes, and training aircrews and if we add to that the attrition in wartime that occurs when you attempt a passage over unfriendly territory, I think it is a demonstrable fact that you can deliver a pound of cargo any time in the combat zone cheaper by missile than you can by combat aircraft, even though you throw away the bulk of your missile.

And in this question of troop transport, I do not visualize at the moment the volume requirement over long distances that I think Dr. von Braun visualized, but there is no question but what a means has to be developed by which Army special forces can be put where they are wanted and the special forces are usually groups of 3 or 4 people and this is a game we have to know how to play, and when the time comes that you cannot get them in there by airplanes, that the defense system effectively precludes this without a very high degree of risk and high percentage of loss, there still has to be some way of getting this small group in there with what you need and get it in behind the areas controlled by others.

The only solution to that problem that I see is missiles.

Mr. FELDMAN. You conceive, in other words, almost a complete defense against invading aircraft?

General MEDARIS. I think this is quite true. I think this is in the foreseeable future and I believe everybody recognizes it, certainly against that type of aircraft that can be reliably used for delivery of personnel and cargo.

To what extent it may be possible to develop aircraft-type vehicles that are clear up to the boundary line between the atmosphere and space, and who, by their tremendous speed, can protect themselves, this does not enter into the other problem, because with those you cannot deliver accurately these small quantities of cargo and small numbers of people that are required at specific places in any fast-moving and wide-ranging patterns of warfare.

Mr. FELDMAN. Also, you could work on both developments at the same time and possibly come up with a solution the other way as well as this way.

We know also the fact that this type of aircraft we are talking about would have a rocket thrust for the most part. Is that right?

General MEDARIS. That is true.

Mr. FELDMAN. It would be a kind of hybrid rocket.

General MEDARIS. In a sense, yes.

Mr. BROOKS. Of course, manned aircraft may reach astronomical speeds, too.

General MEDARIS. That is quite true.

The kind of mission I am talking about depends on lower and slower aircraft for its accomplishment. It just cannot be performed by tremendously high speed aircraft at extreme altitudes.

Mr. FELDMAN. What do you consider the most logical and practical sequence of essential steps or phases in a coordinated space program?

General MEDARIS. The Army Ballistic Missile Agency submitted some time ago their suggestions for a national integrated missile and space vehicle development program. That is in the hands of the people who are concerned with this. It is a rather detailed approach to the whole problem.

Mr. BROOKS. Could you put that in the record, General?

General MEDARIS. It is a classified document. I will be glad to have it transferred to the committee, as such. It is a classified document because this is an integrated space and weapon program.

Mr. BROOKS. You can hand it to counsel, then.

General MEDARIS. We will transfer it to counsel as a classified document.

Mr. FULTON. Is there any part, Mr. Chairman, that can be declassified?

General MEDARIS. From it there can be derived a perfect series of steps that appear to us to be logical in the movement in the space area.

Mr. FULTON. Could we have that kind of statement produced by the General for the record at this point?

General MEDARIS. We will do so.

Mr. FULTON. If there is no objection.

Mr. BROOKS. If there is no objection, it will be inserted in the record at this point.

(The material referred to is classified by the Department of the Army.)

Mr. BROOKS. It is 12:30. We are going to meet again at 2 o'clock.

Mr. FELDMAN. Supposing I submit the questions for the record, General?

General MEDARIS. We will be glad to submit the answers for the record.

(The material referred to above follows:)

Answers to Questions

Question 1. In regard to our space program, what is your opinion on the merits of a single military responsible agency versus a single civilian responsible agency?

Answer. I believe that the management of military and scientific space programs can be most effectively accomplished by placing the managerial responsibility for both programs in the hands of a single individual, preferably within the Department of Defense. I do not believe that such overall control should be a military operation, controlled and directed by a military man. It can, however, work either within or outside the Department of Defense.

Question 2. Do you feel that the separation of military and civilian scientific phases within the same agency is practicable?

Answer. It is my opinion that the military and civilian phases of space research and development cannot be practically separated within the same agency because the two phases are inextricably related. The ballistic missile, after all, is still the basic building block of any space program.

Question 3. What is your opinion of the merits of competitive programs within the Military Establishment?

Answer. I believe that the practice of conducting competitive programs within the Military Establishment is a practical means of stimulating development and at the same time assuring the Nation that all of its eggs are not in one basket.

Question 4. Do you feel that our satellite program in support of the IGY should be divorced from our military effort?

Answer. I believe that the decision to divorce the IGY satellite program from military effort was not the best one, since this work is directly related to the ultimate development of military satellites; however, Monday morning quaterbacking in this business requires nothing more than a willingness to talk. I wish to affirm my opinion that the people who made this decision were doing their best to make that decision a good one.

Question 5. What has been achieved by the organization of the United States Army Ordnance Missile Command?

Answer. The United States Army Ordnance Missile Command was established to provide centralized direction and control of all Army missile development resources and activities. The scope of the command's responsibilities includes direction and control of the entire sequence of weapons-system development, from feasibility study to field support of the tactical system when it has been deployed. This centralized-systems management, located in one place, assures continuing cognizance and coordination of all Army missile-development activity, and permits the immediate accomplishment of any action required to make an assigned weapons system usable in the field.

Certain elements of the Army Ballistic Missile Agency which provided across-the-board Army cognizance of all activity related to missile development were made available to all missile systems assigned to the Ordnance Corps. Several elements of the new command headquarters maintain direct and continuing contact with other technical services of the Army, and with other responsible Army elements. In this manner, the command determines current requirements and military characteristics, and in special cases provides direct support for activation and training of new troops to fit the development of new systems. Other command elements provide the means to efficiently operate the resources under the command's direction, assuring optimum development of new systems, continuing support of missile systems in the field and the proper phasing-out of systems and materiel as they become obsolete.

The proper definition of a weapons system must include not only personnel, materiel, supporting logistics, and technical resources, but must also include the integration of the system and its using personnel with the total tactical system that is required to make a weapon an effective part of the user's arsenal.

Complete systems management envisages a degree of coordination and, where authority does not exist for coordination, envisages participation in establishing requirements, and subsequent system examination to bring any system deficiencies to the attention of the responsible headquarters.

The organization of the command headquarters is streamlined and compact, and can assure fast and effective decisions as they are required. This capacity for immediate action in high priority programs is aided by the delegation of special powers to the commanding general of the command, which gives him direct access to the Army Chief of Staff. Additionally, all Army resources which related to the high-priority missions of the command have been made responsive to the needs of the command's programs.

Question 6. What are the scientific values of an unmanned and manned space program?

Answer. I believe that the scientific values of an unmanned and manned space program are virtually innumerable, encompassing revolutionary contributions to the fields of communications, meterology, geodetics, etc. I also believe it foolish to wait for an assessment of expected gains before beginning preliminary space research.

Question 7. Some feel that space exploration should be a pure civilian scientific venture over which the military should have no control. What is your opinion?

Answer. The point is not whether space exploration should or should not be a pure civilian venture; the point is that historically no nation has ever laid claim to anything and held it without military support.

Question 8. Why is the Army concerned with space exploration? What is the Army's need with relation to space travel?

Answer. The Army is immediately concerned with space exploration as it relates to communications, weather intelligence, troop and cargo transport, etc Additionally, as man extends his activity away from Earth he will inevitably carry with him the same basic needs which he has on Earth, protection included. Aside from those space exploration activities which relate directly to its missions, the Army is interested in space research because it has, now, the ability to make a singular contribution to the mastery of space, without regard to whether this contribution is in support of its own missions or not.

Question 9. It would appear that using missiles for troop movement and support would be much too expensive. How can you reconcile the cost factor?

Answer. I believe it is a demonstrable fact that a pound of cargo can be delivered to a combat zone more cheaply by missile than by combat aircraft. This opinion is well reasoned if one considers the figures concerning the cost of acquiring and maintaining aircraft, training aircrews, and adds to these costs that of the attrition of aircraft during attempted passage over unfriendly territory during time of war.

Question 10. What do you consider the most logical and practical sequence of essential steps or phases in a coordinated space program?

Answer. I consider the most logical and practical sequence of steps in a coordinated space program to be the following:

1. A moon probe;
2. The launching of a manned satellite;
3. A moon landing and return; and
4. A planetary probe.

Question 11. Which of these might be effectively pursued concurrently by different activities?

Answer. Again, I wish to point out the advisability of assigning the accomplishment of these steps on a competitive basis whenever possible, to make certain that their sequence is orderly and timely and that the failure of a single project does not spell failure for the entire program.

Question 12. What are the separate projects that should be undertaken in a national program?

Answer. Some of the separate projects which, in my opinion, should be undertaken immediately include: (1) Development of an engine of much greater thrust; (2) development of various types of satellites, i. e., communications, visual surveillance, manned satellites, troop carriers, supply vehicles, satellite interceptor systems, etc.

Question 13. Has the Army ever offered for consideration any kind of unified space program?

Answer. The Army Ballistic Missile Agency has submitted to the Chief of Research and Development, Department of the Army, a proposal entitled "A National Integrated Missile and Space Vehicle Development Program." On February 19, 1958, the Army recommended that the Department of Defense implement the provisions of this proposal.

Question 14. What space capabilities does the Army Ordnance Missile Command now possess, both scientific and military?

Answer. The United States Army Ordnance Missile Command has within its framework the capacity for accomplishing a significant portion of this Nation's ballistic weapons and space vehicle development. The Development Operations Division of the Army Ballistic Missile Agency, under the direction of Dr. von Braun, is staffed around a nucleus of well-known authorities in the field of astronautics and missile development. Certainly the capabilities of this unique concentration of experts, coupled with the capabilities of the Jet Propulsion

Laboratory, must be utilized if this Nation is to accomplish the true integration of a national space program. The United States Army Ordnance Missile Command will continue to make proposals placing its available developmental capabilities in support of any agency which has need of them.

Question 15. What capabilities can it develop for the future?

Answer. The recent organization of the United States Army Ordnance Missile Command assures sustained, concentrated surveillance of research, development and production in the field of missiles and in the research and development of hardware for space exploration. The inhouse developmental production capability of ABMA, plus that of Jet Propulsion Laboratory, plus the contracted capabilities of the many private industries supporting command programs, are being constantly assessed to maintain a continuing knowledge of the command's ability to absorb new programs. As technology matures, pointing out weakness in some programs and strength in others, the command organization will permit a shift of emphasis to any developmental area. In this manner, the activities of each command agency can be quickly fitted to the demands of the future.

Question 16. What responsibilities have been placed on the Army with regard to satellite and space programs?

Answer. With the firing of Jupiter C missile 29 on January 31, 1958, the United States Army launched the first United States satellite, Explorer I, into orbit. Explorer II, fired with Jupiter C missile 24 on March 5, failed to orbit because the missile's fourth stage rocket did not ignite. The Army's third satellite firing was attempted 21 days later, and was completely successful in placing Explorer III into orbit. Early indications that Explorer III's orbit was not a healthy one proved incorrect. The satellite is fulfilling its missions. Incidentally the launching of Explorer III was scheduled immediately after Explorer II did not go into orbit; this is the finest proof of the Army's flexibility.

Currently assigned ARPA (Advanced Research Projects Agency) projects include:

(The rest of the answer to question 16 is classified.)

Question 17. How do you feel the Army can best contribute to satellite programs and space programs?

Answer. I believe that the Army can most effectively contribute to satellite and space programs by being allowed to pursue the programs which AOMC has recommended. A summary of the AOMC space program proposals will be submitted to this committee.

Question 18. What capability has the Army for putting a man into space and having him return safely?

Answer. AOMC has recently made a proposal entitled "Project Adam" which would launch a man into space. The launching would be accomplished within a Redstone missile. Because the reliability of Redstone is an accomplished fact, the launching could be carried out within 1 year.

Question 19. What breakthroughs, if any, are required to succeed in a coordinated national space program?

Answer. The major breakthrough which must be effected before any national space program can gain substantial impetus is the development of engines of much greater thrust. I am convinced that we must have a well-tested capability of a minimum of 1 million pounds thrust, either by a combination of multiplex engines or by a single engine.

Question 20. When can you expect to make the first moon contact?

(Answer to question 20 is classified.)

Question 21. When can you expect to establish the first manned satellite?

Answer. Before any valid estimate can be made of the time required to place a manned satellite in orbit, it is first necessary to know much more about man's behavior in space for a shorter period of time. For this reason I consider approval of Project Adam of paramount importance.

Question 22. What sort of schedule is necessary to overtake the Russians in a space program?

Answer. If the Russians are to be overtaken we must have an integrated missile and space vehicle development program, similar to that recommended to the Department of Defense by the Army.

Question 23. What specific hardware items must be developed immediately to achieve the goals of a national space program in the period 1960–70?

Answer. Again, engines of greater thrust.

Question 24. Why should the Army be concerned with large engine development?

Answer. I believe that the United States Army must make long-range plans for the transport of small combat teams by rocket. I also believe that cargo transport by rocket is economically feasible. To accomplish these things an engine of greater thrust is necessary.

Question 25. Is basic research—the ideas yet unborn—in need of greater financial support than is currently being given?

Answer. Basic research is always in need of greater financial support. In light of Russia's demonstrated lead in ballistic missiles, it is now mandatory that this need be met with adequate funding. It should be pointed out, however, that the dollar requirement for basic research is very small, applied research is the big money user.

Question 26. Is the Army receiving sufficient funds for applied research to attain the advances necessary for successful fulfillment of a national space mission?

Answer. It is my opinion that the Army is not receiving sufficient funding support of applied research. Research projects should be funded separately—funded as research and not tied to a missile program. Engine development, for example, should be funded as an entirely separate research and development program.

Mr. FULTON. This line of questioning as to the size of rockets for carrying brings up the question that has been worrying the public off and on and that is this: How about these space saucers? Are there such things? Do you give any account to them, or is that just a thing out of a book?

General MEDARIS. I have not been able to lay my hand on any evidence that I consider credible that such vehicles exist. I have, however, in this program that we are in these days, reached the point where I never say it is not so; I do not know.

Mr. FULTON. On the ionized rocket program at Los Alamos, it is estimated to take about 10 years before operation. Do you know any way that could be hurried up?

General MEDARIS. I doubt it. This is a very advanced propulsion system and our own calculations have indicated this is a reasonable period.

Mr. FULTON. There has been some contradictory testimony here as to the value of a research program on photon propulsion. Do you feel that is in the realm of practicality, that we should have a basic research program on photon propulsion?

General MEDARIS. I think a basic research program on it would be warranted. The purpose of the basic research program is to clarify this doubt. There are differences of opinion.

The only way you clarify them is to go far enough in the area of fundamental research to either come up with the conclusion that it is an approach that can be successfully followed through, or that it is not. So, definitely there should be a basic research program in that area in my opinion.

Mr. FULTON. Because of the tremendous weight factor, that is, on modern propellants, do you think, when we could by 1 pound of uranium take the place of a thousand tons of coal in energy or propel a rocket of tremendous size, there is enough being done in the study of our fuels and propellents for rockets and for space vehicles and missiles at the present time, or could that not be tremendously expanded?

General MEDARIS. The problem is one of timing, Mr. Congressman. It depends to a great extent on the time when we can expect to have available a successful and reliable atomic powered propulsion system.

Now, as far as the other fuels are concerned, we have explored the entire spectrum. We know where the possibilities are, and we feel

that the atomic-powered missile of reliable character is far enough off that the intervening gap should be covered by further progress in the area of the so-called exotic fuels, chemical engines.

Mr. FULTON. Do you think that more emphasis should be put on the hypergolic fuels that ignite on contact rather than the oxidation fuels?

General MEDARIS. The best of the oxidation fuels are also hypergolic. They are not monofuels.

Mr. FULTON. On the second stage, right now, of the Vanguard weapon we, of course, use the hypergolic fuels. The question I am raising is: Should we, on that intermediate stage, put more emphasis on the development of that type fuel, or should we just simply put the emphasis on the solid and the rubber-impregnated or artificially rubber-impregnated fuels?

General MEDARIS. The solid fuels, I believe, are consistently going to lag behind in their ability to give us the major areas of thrust that we want. Now, they are supreme in their field, but it is sort of like the difference between a diesel engine and gasoline engine, you don't use them for the same application.

Mr. FULTON. Where should the pressure be put on the development of new propellents? Should it be on the latex pressurized solid fuel, on the hypergolic fuels?

General MEDARIS. We think in general it is on the hypergolic chemicals. We would like to be into a program right now of developing an engine at about a third of a million pounds which could be multiplexed against a known combination which I would prefer not to put in the record, which will give us a substantial increase in efficiency and which we know we can handle.

And we would like at the same time to be into a reduced applied effort at a reduced scale of thrust for upper stages of the next stage beyond that which we believe from analysis is the best chemical fuel that we could ever tolerate, and the next step from that is your atomic rocket.

Mr. FULTON. That is the first step I am trying to come to, and I appreciate your saying it.

How much would the original step that you have spoken of in the hypergolic fuels cost and what would be the amount of time that would be involved on such a research program?

General MEDARIS. I believe we can come to this intervening step of a third of a million pounds, we can come to that in a matter of a minimum or a maximum, I should say, of 3 years. We could have an effective operating engine.

Mr. FULTON That would really permit us, then, to put into orbit a manned space satellite of some size?

General MEDARIS. Yes; because it could be multiplexed in 3, which is a very efficient engine, incidentally, and possibly much larger than the ton size that the Soviets are now speaking about.

Mr. FULTON. Also, it would give us not only surveillance but also military capability of a manned space satellite.

General MEDARIS. The size potential out of such an engine combination I am talking about, in terms of a multistage vehicle, would pretty much let us choose what you want to put in.

Mr. FULTON. That would be able to come in what period of time, if we put the push on an urgency program to get one-third of a million pound thrust engine?

General MEDARIS. Well, this goes through steps. All of this is outlined in this coordinated program.

Mr. BROOKS. Have we spent enough money on solid propellents for fuels?

General MEDARIS. I think so, in that area; yes.

Mr. BROOKS. Were we slow on getting into the development of solid fuel?

General MEDARIS. No, there were certain fundamental breakthroughs that had to come through in the research area before we could go forward.

Mr. BROOKS. All these breakthroughs are available to us now?

General MEDARIS. That is right. It is now a question of advancing, of engineering, more efficient motors, more stable against temperature changes, having longer storage life and somewhat greater efficiency.

Mr. BROOKS. What about the liquid fuels? Have we reached about the limit in the progress of development of liquid fuels?

General MEDARIS. There are at least two major steps more that can be taken in liquid fuels.

Mr. BROOKS. You would change the constitutent parts?

General MEDARIS. That is right.

Mr. BROOKS. And new constituent parts would give us considerable progress?

General MEDARIS. That is right.

Mr. BROOKS. You still would place more emphasis on liquid fuels than solid propellents?

General MEDARIS. For your heavier carriers, they can get there faster than your solid propellent in these areas.

For the thing we are talking about, you need high thrust for a long period and it will take quite a long time before you can get solids in that area.

Mr. BROOKS. Liquid fuels are more difficult to handle, are they not?

General MEDARIS. It is purely an engineering problem. When you consider the problem of getting the solid fuels into the rocket in the first place, if you consider that as part of the difficulty, the answer is no.

Mr. BROOKS. Of course, if you are thinking exclusively of long-range missiles, where you have a launching base, but you have a shorter range missile, the liquid propellent is not as transportable.

General MEDARIS. We are moving as fast as possible on the solid in the shorter range missiles.

Mr. BROOKS. I have thought for some time we have not been giving the emphasis we could on propellents and we were putting the emphasis on rockets instead of propellents.

General MEDARIS. There has been a lot of emphasis on both.

Mr. BROOKS. Your command, by its name, has control of missiles, but do we have a command that has the obligation of developing propellent materials?

General MEDARIS. We have this likewise, as far as the Army's responsibility.

Mr. BROOKS. A separate command?

General MEDARIS. No, sir, it is within my command.

Mr. BROOKS. You think we are placing emphasis enough?

General MEDARIS. I think relative to the place it has in the whole area and the virtues of the solution, we are placing adequate emphasis on it.

Mr. BROOKS. I could go along and not have any recess, but we have a man here who has done yeomanlike duty in taking these notes. He has to be back here again at 2 o'clock.

Mr. FULTON. Also, for the record, Mr. Chairman, I should like to say that the reporting service rendered by this gentleman here, during the course of these hearings, has been about the best I have ever seen.

Can we ask how much money you would like to have for a third-of-a-million-pound-thrust engine?

General MEDARIS. A development program in terms of $50 million.

Mr. FULTON. $50 million would give you an urgent space program that would adequately move us ahead in that field?

General MEDARIS. I think so.

Mr. BROOKS If there is no further business, the committee is adjourned until 2 o'clock.

(Thereupon, at 12:40 p. m., the committee recessed, to reconvene at 2 p. m., same day.)

AFTER RECESS

(The committee reconvened at 2 p. m., Representative Overton Brooks presiding.)

Mr. BROOKS. Will the committee please come to order?

The Chairman, Mr. McCormack, has just called and said he would be a little bit late and he has asked us to go ahead in his absence rather than to delay the hearing.

We are always glad to have General Gavin. I have had the good fortune of hearing you testify before, but I look forward with just as much interest to your testimony on this occasion.

General, do you have a prepared statement?

STATEMENT OF LT. GEN. JAMES M. GAVIN,[6] RETIRED, FORMER DEPUTY CHIEF, OFFICE OF RESEARCH AND DEVELOPMENT, ARMY

General GAVIN. No, sir; I do not have a prepared statement. I have appeared before this committee in executive session. Upon request of the chairman, I agreed to make myself available when I could.

Mr. BROOKS. Do you have a general statement you want to preface these questions with?

General GAVIN. May I say, then, to the best of my memory I would repeat what I said a couple of months ago. First, I am far

[6] GAVIN, James M., army officer, b. New York, N. Y., Mar. 22, 1907, s. Martin Thomas and Mary (Terrel) G.; B. S., U. S. Mil. Acad., 1929; grad. Inf. Sch., officers course, 1933, Command and Gen. Staff School, Parachute School, married 2d, Jean Emert Duncan, July 31, 1948; children—Caroline, Patricia, Aileen, Chloe, 1 daughter (by previous marriage), Barbara Margaret. Enlisted as private United States Army, 1924, commd. 2d lieutenant, inf., 1929, and advanced through the grades to major general, 1944, as commander 505th Parachute Regimental Combat Team, landed with command by parachute, Sicily, July 10, 1943, Salerno, Italy, September 13, 1943; as assistant division commander 82d Airborne Division, landed with command by parachute, Normandy, June 6, 1944, as div. comdr. 82d Airborne Div. landed with command by parachute in vicinity of Nijmegen, Holland, Sept. 17, 1944, participated in reduction of Ardennes penetration, 1945; dep. chief of staff for plans and research, 1955—. Decorated Distinguished Service Cross with oak leaf cluster, Purple Heart, Silver Star, Distinguished Service Order (British). Author. Airborne Warfare, 1947. *Address: care Secretary of Defense*, Washington 25, D. C.

from authoritative on the subject of space. There are no doubt many more able spokesmen on the subject than I. I have, however, been associated with it since Dr. von Braun and the Secretary of the Army Stevens and I and General Ridgway talked over a proposed satellite program back in 1954.

In the meantime I have learned the language and have done a great deal of studying. In the meantime, I have taken an increasing interest in the subject. I am particularly interested in the military aspects of the program, feeling that they were of tremendous significance.

Appearing before Senator Johnson's committee on December 13 of last year, at that time I stated I thought that the solid rockets were the most significant in the military sense of that word, ahead of our times, which I still believe is true.

Other than that, I know of nothing that would be a substantive prelude to any questions you may want to ask me. I will gladly make myself available to you any way I can.

Mr. BROOKS. Do you believe, then, General, that this development in the satellite program has vast possibilities for the security of our country and for the progress of mankind?

General GAVIN. There is no question about it, sir; I absolutely do. The record is quite clear on this point.

I have addressed a half dozen memorandums to the Department of Defense over the past several years, seeking on behalf of the Department of the Army, authority to launch a satellite. I have worked in research and development and in weapons systems analysis for quite a few years and I am impressed, as I believe are all of us with any background in the science, with the need for understanding of the future, the need for vision.

The more dynamic the technology of the day becomes, the more you need to strive if you are going to survive. Obviously the satellite is the most tremendously impressive vehicle of our time. While we do not exactly understand its immediate military application and we will not until trial and test, the very basic functioning of it is adequate warning that it means a great deal, and we had better get after the satellite and do something about it.

Mr. BROOKS. And we had better do it first, too. Do you agree on that?

General GAVIN. No question about that.

Mr. BROOKS. You have said that you have made repeated requests for the development of the satellite program. What was the answer to these requests that you made?

General GAVIN. I would say that they were given a very good hearing and the replies were good evidence that they had been gone into quite carefully, but in conclusion they instructed me not to undertake a satellite program.

The last such memorandum I remember the wording of was one of May 1956, addressed to me in person, that concluded with the statement, rather, used the second person pronoun, "You will not undertake the satellite program using the Redstone or Jupiter missiles," signed by a Deputy Assistant Secretary of Defense.

Mr. BROOKS. What was the date of that?

General GAVIN. To the best of my memory, May 1956.

Mr. Brooks. That was before the trial of the Jupiter C, when it rocketed up 3,300 miles, because on September 20, 1956, in experimenting with the Jupiter C, you got it up to 3,300 miles.

General Gavin. That is correct, sir.

Mr. Brooks. So you got the red light on your program in May before then?

General Gavin. Yes, sir; we had from the beginning. Our concern stemmed from two sides of the problem.

First, we had analyzed our own capabilities in terms of the Vanguard with considerable care, and we were quite uneasy lest our country fail to meet its IGY commitment as it appeared to us we would. I will say to you frankly we thought in 1956 we would not get Vanguard up in the year 1958, as we saw it.

Mr. Brooks. That was an IGY commitment?

General Gavin. Yes, sir; we had agreed we would launch one and we were quite afraid that the scientists of our country would be quite embarrassed and our Nation, if we failed. We felt, next, it could be done, unquestionably, it could be done, if we were allowed to go ahead and then we were beginning to feel a trifle uneasy about the Soviet program.

We really were not as impressed as we should have been with it, however, until the spring of 1957 when it became quite clear then that they were making much greater progress than we had anticipated a year earlier.

As you know, in the summer of 1957 they announced having fired a long-range missile. At the time of Suez, of course, they threatened the use of rockets and in August of 1957 they announced—Mr. Khrushchev announced—that they had fired an intercontinental ballistic—he did not say missile—device that landed in the target area, some wording such as that.

All the evidence we had made it quite clear that they had reached outer space already. So in mid-1957 we were at the point of worry then.

Mr. Brooks. Do you think that the reference to a device that reached its target area meant that that was a satellite or do you think it was an intercontinental ballistic missile?

General Gavin. I am not sure what Mr. Khrushchev referred to, sir, in 1957, but I am satisfied that the state of technology in the Soviet Union is such now that they do have an ICBM.

Mr. Brooks. Do you feel they are way ahead of us in reference to this program?

General Gavin. I would say they are ahead of us.

Mr. Brooks. How far ahead of us?

General Gavin. It would be difficult to put a finite number on it. Sputnik II is a demonstrably bigger satellite than Explorer and Vanguard, and obviously would require a much larger main thrust unit and this immediately applies to ballistic performance. You have the remaining warhead guidance which, if they solve that properly, they have no problem. It is hard to say.

Mr. Brooks. Would you say they are ahead of us because our people were not allowed to go ahead with the program, or are they ahead of us because we have inferior scientists?

General Gavin. There is no question about the answer to that one. We have the scientific talent and we have the brainpower, the indus-

trial capacity and energy to do these things. The failure was in decision-making, making the wrong decisions.

Mr. BROOKS. The wrong decisions put us behind on the programs?

General GAVIN. No question about it.

Mr. BROOKS. If we get the right decisions now, with the talent and ability and with the proper amount of finance behind us, we can overtake the Russians, can we not?

General GAVIN. With a great deal of hard work; yes, sir

Mr. BROOKS. Hard work and long hours.

General GAVIN. Adequate funding.

Mr. BROOKS. And proper decisions.

General GAVIN. No questions about it.

Mr. BROOKS. I believe you added adequate funding

General GAVIN. Yes, sir.

Mr. BROOKS. Have you given any thought as to how much money we will need to get this thing going?

General GAVIN. No, sir; I am not in a position to put an actual dollar figure on it. I would express it this way: That we need a broad approach We must not worry about duplication in research. One cannot foresee the future so well that in research you can pick the one thing that is going to pay off and exclude all others, so you must spend money on research.

So by adequate funding I mean little restraint on funding for research. Spend money on research and it will pay off later on. The big decision in research and development is not when to start something, but when to stop something.

I know that the funding programs come before you gentlemen and I should say they should be fully funded in research and decision made where to chop it off later on.

Mr. BROOKS. How far were we retarded by these bad decisions? Would you say a year, 2 years, or 3 years, or how many?

General GAVIN. Sir, there are two aspects to this question With the state of technology widely appreciated and understood of about 2 years ago, decision then could have given us a satellite very quickly perhaps in a few months, so that we could have had a satellite up about a year and a half ago, something of that sort

But the other aspect of it is that by greater vision and a greater willingness to seek innovation in new areas immediately following World War II and a full funding of missile programs through the years 1946, 1947, 1948, 1949, 1950, I will say we could have had a satellite significantly ahead of the year and a half. Perhaps we could have had one—I do not know that I can put a number on this, but a year or two ahead of that.

Next to losing a war, the greatest danger that can confront a nation is to win it because having won it you become complacent and you assume that what you won it with will serve you in the future. There is a historical pattern that shows that this is one of the really great pitfalls of any people.

Preoccupation with a single weapons strategy that has won for us in the past is certain to bring us disaster in the future because you must look for new ideas and new innovations and we seem to have closed our minds to new ideas in the latter half of the 1940's.

Mr. BROOKS. The reason I ask v··· that is not to put the finger on anybody or to be critical.

General GAVIN. I understand.

Mr. BROOKS. Then you find no fault in the training of our scientists in this country or the capability of these scientists?

General GAVIN. Our scientists are as good as any in the world. Of course, I am quite biased as an American would be, but I do believe their record of performance is quite clear. Scientists are concerned with the schooling problem because it comes down to this in the last analysis. We are in a very dynamic technological age in which survival will be based on innovation and breakthroughs which come unexpectedly and completely change the pattern of strategy and tactics

Now, breakthroughs come in proportion to the minds on a problem. If nation A can put 1,000 brilliant scientists working in this new field and nation B 100, the chances are that nation A will come up with 10 more ideas in a given period of time than nation B, and the chances are they are 10 times more likely to come up with a breakthrough than nation B.

So it comes back, then, to the training of scientists and we should have a school program that gives our scientifically inclined youngsters an opportunity to go into the sciences, encourage them to go into the sciences.

This would not exclude the liberal arts, because we should push those things, too. This, I suppose, means that we should work harder in our schools in all these fields, liberal arts as well as the sciences.

Now, to get back again to the original answer, our scientists are top flight I have no reservation about that answer whatsoever. However, we should put our minds to the scientists in the future and be sure we have an adequate quality and quantity in the group coming along

Mr. BROOKS. That is a fine explanation. I want to ask you this question. You are out of uniform, now, and therefore you can speak freely. We appreciate that fact and it makes you a very valuable witness to the committee.

If you were down there in Redstone, what changes would you make in the program or the setup in the interest of developing the satellite, the rocket and the missile programs?

General GAVIN. The way the Army Ballistic Missile Agency and Redstone Arsenal is funded today, I doubt that I would make many changes. Frankly, I would probably have General Medaris and Dr. von Braun in, or I would go down and see them and wonder why they were not doing more and demand the impossible of them every few weeks or so and then give them money to go ahead and do it

But they are adequately funded. They have approved programs now and more cannot be done with those, but I would sure push them for new ideas.

Mr. FULTON. You were not here this morning when we did just that?

General GAVIN. I might say that while we have been awaiting this hearing we have been reading the old bulletins of the atomic scientists back around 1946 or so. It is an impressive state of affairs, the lack of ability to see where you are going in technology and it is interesting to go back and read 10 years back the statements and articles by our scientists of where we were going.

It is discouraging. Innovation is such a rarity it is very difficult to push through new ideas. I think the best thing that could be done in Redstone Arsenal would be to encourage them that they do more and demand that they do more.

Mr. BROOKS. In other words, give them a little more freedom in their thoughts?

General GAVIN. Absolutely.

Mr. BROOKS. And require more in the way of an effort. Those two things? Is that what you have in mind?

General GAVIN. Yes, sir; I would demand more of them and push them.

Mr. BROOKS. You think, then, we could make much better progress with those two concepts placed into operation?

General GAVIN. Yes, sir.

Mr. BROOKS. Mr. O'Brien?

Mr. O'BRIEN. General, I was interested in your statement about science education. I understand you feel we have a great need for scientific knowledge now, but our danger or concern lies in the future, that we must start now to make sure that the Russians do not get too far ahead of us in that particular field?

General GAVIN. Yes, sir; that is correct.

Mr. O'BRIEN. My question is this: What can we do to get greater benefit out of the scientific know-how we possess? The reason I ask the question is that a statement was made the other day that occasionally one of these projects is abandoned or terminated for some reason. Then you have a number of skilled people who are suddenly cut adrift who might go to private industry, or I do not know where they go. Then, when you go to another project, you have to reassemble a number of them. Is there any way of keeping such a force together?

General GAVIN. I know of none for the mass of the skilled scientific workers. We rather well keep track of our top scientists in this country and they are well known by reputation and we know the projects they are putting their minds to from time to time, but I know of no centralized way of controlling these people.

I believe I understood, too, your concern, because we are wasting a great deal of our scientific talent. Sometimes it is stockpiled by industry, too, in the hope of getting contracts, when it is needed badly in another area.

Mr. O'BRIEN. That is the thought I had, that it was stockpiled by industry. I was wondering if there was not some way that the Government could do some stockpiling in that field, perhaps by contracts or something of that sort.

General GAVIN. I know of no way that we could do it that I can recommend.

Mr. O'BRIEN. Do you not feel much of our weakness in this whole field has been the fact that all of us respond largely to panic? In other words, we demanded immediately after Sputnik a crash program in science education. The creation of this committee and its counterpart in the Senate came about as a result of our excitement over those things and sudden realization that the Russians were ahead of us.

Now, do you not think that while we are attempting to catch up that we should concentrate more on leapfrogging and getting ahead of them?

General GAVIN. I am glad you asked that question. I would agree, yes. I read once again the statement that came from our scientists on March 26 about the subject of space. I thought the best sentence was the vary last one. It reads:

> It therefore appears wise to be cautious and modest in our predictions and pronouncements about future space activities and quietly bold in our execution.

There has just been too much alternating between hysteria and elation and not enough steady hard, solid work. We are going to have to get down to business if we are going to get ahead now.

The other point you mentioned, of course, is one that was quite fundamental in this situation, and that is the tendency to surrender the technological initiative and lead to someone else. If we do that we will never survive. We have to strike boldly on our own.

This applies in this situation. I recall specifically on December 13 hearings in Mr. Johnson's committee the question was asked of numerous witnesses, "What is more important, a missile program or a space program?"

To my surprise, many of them said a missile program. Well, this could not possibly be so because we are in the space age and a space program includes a missile program. You cannot get space vehicles up without missiles and a space program is far more important.

You will find the record will show that many people turned their mind against space and just said missiles because missiles then were in the headlines and the Soviets were threatening us with them and they were being used, and so on.

We will never survive without striking out boldly and lead the parade of progress and let other people follow us.

Mr. O'BRIEN. You feel this committee, for example, in addition to providing the so-called hardware for going ahead with the things we have already developed, should make substantial provision for pure research to permit certain people working for the Government to come up from time to time with something that is new and radically different from the things we propose to manufacture at this time?

General GAVIN. Absolutely I would certainly agree with that.

Mr. O'BRIEN. Thank you very much.

Mr. BROOKS. Mr. Metcalf?

Mr. METCALF. General Gavin, one of the functions of this committee, and one of our missions, is to find out where to put this whole space thing in the Government. The President sent up recommended legislation. In his recommendations he said:

> I recommend that aeronautical and space science activities sponsored by the United States be conducted under the direction of a civilian agency except for those projects primarily associated with military requirements.

Do you agree with that?

General GAVIN. Yes, I agree with that entirely.

Mr. METCALF. What sort of civilian agency should we create?

General GAVIN. Of course, most of us consider this, I suppose, in terms of our recent experience with the Atomic Energy Commission and I remember the arguments when that was established.

I remember, too, that few people saw any application for fission except a military application. It is quite interesting to go back to 10 years ago about the future of fission. Very few people saw the widespread civilian application of the products of fission. Today

perhaps they are 90 percent of the program and the military business is a very small part of it.

So I am thinking along the lines that we have developed the Atomic Energy Commission because I do believe that the civilian application of the space program will be far more important than the military. So it should be under a civilian agency. Furthermore, you would disassociate it from service problems, service budgeting problems which can become very serious in peace.

I should think it should be and it can be done and the military programs can be conducted as they are today, through the congressional committee. I know the Military Application Subcommittee of the Joint Atomic Energy Committee has worked very well and I know that the programs are moving along very well and our country has good reason to be proud of them.

We are developing weapons that will serve our people and we are packaging them in tactical form to give us an adequate air defense, a defense against missiles and give us weapons that can serve us and serve our Armed Forces. A great deal of that is due to the inspiration and impetus given us by this committee.

I would think a parallel situation could readily develop in the space program and we could have a committee such as you gentlemen here and a joint committee push the program along and be able to urge the thing to be done without the restrictions that would come from military control of it. I think the proposal is a very good one.

Mr. METCALF. General Gavin, as you know, the recommendations that have been sent to this committee by the President include an advisory board of 17 members, 8 from the Government and the rest from industry, who meet not less than 4 times a year. So that would be a part-time board in charge of this affair, advising the Director and the President.

Would you suggest, in your experience, that would be a better way of organizing this civilian agency or a full-time board such as the Atomic Energy Committee, composed of commissioners, composed of fewer men?

General GAVIN. I must say I do not know. I do not have enough experience to say. At the moment I feel that certainly, at first, it should be a full-time committee until we felt sure we had the situation in hand, but I do not know. I should not give an opinion on this.

Mr. METCALF. That is a decision that is going to confront this committee. I am in hopes that out of your experience you would point a way toward either a permanent committee or perhaps part-time.

General GAVIN. You know, I tempered my answer with the reservation that I would want to feel that the situation was in hand before we decided to meet occasionally from time to time. Let us have no illusion about this. The complacency is still running deep and strong in this country on the problem of space and just to appoint a group to meet once in a while or every so often to take care of things to me would not be adequate as I see the situation now.

I would want to feel it is well in hand before we go home and decide to talk about it months later. We have tremendously challenging problems ahead of us and they would deserve full consideration of very able men for some time

Mr. METCALF. Of course, as I understand it, this board of 17 men could meet oftener than 4 times a year. They could probably be in general session at all times, but they are not to be paid anything but their expenses.

It is understood, as I read the legislation, to be a part-time job. Like you, I have some misgivings about a part-time board in charge of this.

General GAVIN. I would certainly be inclined to share your misgivings. Of course, the recommendation may be based upon the advice of some of the fine scientists or advisers or executives and they may be sound, but I am concerned.

Mr. METCALF. I have this question on the business of an advisory board which advises the President and Director rather than a board that has control over the Director.

Do you have any comment on whether we should create a commission to have the control or put the control in the Director and have only board members in an advisory capacity?

General GAVIN. I am not sure until I know more about it. I have not read the draft of it and it would not really be appropriate for me to give a judgment on it, I am afraid.

Mr. METCALF. I did not mean to put you in any position where you had to answer something for which you were not prepared.

General, I would like to read to you this declaration of policy from the administration bill:

> The Congress further declares that such activity should be directed by a civilian agency exercising control over aeronautical space research sponsored by the United States except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with or on behalf of the Department of Defense.

Now, I am unable to find out from that language whether the civilian agency has control over the military part of the program. If you were a general in charge of the missile program, what would your interpretation of that be?

General GAVIN. I certainly would want to get my hands on a copy of it and read it with care. I am not sure without studying it what it would mean. I am sure I would want to talk to the people who wrote it. It does not sound to me like the management procedure used with the AEC in which they have authority to go ahead with the programs given to them by the Department of Defense.

It seems unnecessarily vague and lends itself to misunderstanding at the present moment.

Mr. METCALF. It would seem to me that it probably would not give the Department of Defense enough control over the purely military part of the program.

General GAVIN. Well, if the Department of Defense specifies what it wants, this commission then could see to it that it gets it. The Department of Defense does not of necessity have to control the industrial process or the research programs that get the hardware for them, although I realize they are doing a great deal of that now and they will.

But as I understand it, in addition to what the Department of Defense is doing, this commission will conduct the program by activity or direct activities which may be applicable to the military programs.

Mr. METCALF. As I understand your forecast and prediction, most of the programs conducted will be civilian programs, as this space thing goes along.

General GAVIN. I am personally of that point of view; yes.

Mr. METCALF. Thank you, General.

Mr. BROOKS. Mr. Natcher?

Mr. NATCHER. General Gavin, do you believe that science deserves a place in the Cabinet?

General GAVIN. Yes, I do.

Mr. NATCHER. Realizing the importance of our missile and satellite program at the present time, General, why not just have all of face the facts and realize it is going to cost us a lot of money and proceed accordingly? What do you think of that?

General GAVIN. Of course, that is a good idea. We want to be awfully careful not to get our scientists mixed up with politics to the extent that they are subject to the changing political atmosphere of the Capital, you know. They themselves are not of the turn of mind that would adapt well either to political environment.

Nevertheless, I have thought about this a great deal. My hesitancy in answering was not based upon lacking conviction on a point of view. I do think we should have a top scientist in that position. How to fit him in I am not sure. He should be protected from the vicissitudes of political change that occur around Washington.

Mr. NATCHER. Do you feel that the Government has properly informed the people of the demands of a technological war?

General GAVIN. That the Government has?

Mr. NATCHER. Yes; our Government.

General GAVIN. Sir, that is not for me to say. Obvious overt efforts have been made to inform the people through television programs and the like, and I think they have been impressive and informative.

If our Government considers that adequate, I would not be the one to say that it is not.

Mr. NATCHER. General, do you feel that at the present time we are pooling our scientific knowledge with our allies as we should and receiving the benefits that we could from our allies?

General GAVIN. No; we are not.

Mr. NATCHER. Thank you.

Mr. BROOKS. Mr. Sisk?

Mr. SISK. General Gavin, I am happy to have you before the committee again.

Just to pursue briefly the line of questioning that my colleague, Mr. Natcher, brought up with reference to our allies, is it your opinion that they could contribute a great deal through a proper coordination and a sharing or pooling, let us say, of scientific knowledge and research and development procedures?

General GAVIN. Yes. You know, we all realize that we have no monopoly on scientists, that some of our best scientists have come from Europe. Some of our outstanding scientists are not Americans by birth.

Now, I have spent quite a bit of time in NATO and I look upon the North Atlantic Treaty Organization as really being one of the great instruments of our time, that absolutely must be effective and must work. Collective security is the road to survival for our country.

Yet, one of the most bothersome problems is the free exchange of scientific information. I do not say that the United States is at fault exactly. We all contribute to the problem. But there is a great deal of duplication.

There is a lack of exchange of information, and we are not sharing our thinking and not sharing the work. I wish we were doing much better in this respect. It would bode much better for the future of NATO. This is fundamental to confidence in NATO. We are not doing a good job of it.

Mr Sisk. Do you have any specific recommendation, General Gavin, on how we might facilitate that exchange, either through NATO or through some other vehicle? I think that is important. I am wondering if in your thoughts on this, and particularly in relation with NATO, if you have any specific recommendation.

General Gavin. Yes; I do. Without putting it in the form of a draft, let us say, we get so ensnailed in our own redtape that we cannot get out of it The security restrictions now on certain information are such that we cannot get the ideas across that we should be able to, to ready NATO for the technological age in which it finds itself.

First of all, therefore, the Department of Defense should at least be asked, although they could well take the initiative and ask that legislation be drafted that would enable them to amend the present security restrictions that are so binding and when this legislation is passed and they could go ahead and exchange, then, of course, we could do it.

At the moment, again, you have certain laws, then you have certain directives from the Department of Defense. Then you have certain regulations in a service. When you finally get down to the man who must sit down with another man in uniform in NATO headquarters to get an idea across, he simply cannot do it.

Atomic matters, in particular, are a difficult subject. It stems from the law of the land. The Department of Defense could ask to change it; it might be a good idea to do it that way by proper legislation. Proper encouragement from Congress would enable the Department of Defense to do much more in this field.

Mr. Sisk I would understand your recommendation to mean that through legislative action and possibly through directives from the Department of Defense, we could cut a lot of redtape. It would be necessary to do that in order to bring about any exchange or joint action with our allies in this type of development. Is that correct?

General Gavin Yes; absolutely.

Mr Sisk. Now you mentioned a little while ago a fear of complacency. As I understand it, you fear that we have too much complacency in this country in spite of recent events. Is that correct?

General Gavin. I would say I think so. Perhaps I have been too close to the problem, but I think so.

Mr. Sisk. I might say, General, I share with you that feeling. I have just returned from my own district, as other members have, and unfortunately I think that our people have no realization, to a large extent, of the importance and of, let us say, the mortal danger in which our country and our way of life may be.

I will ask you this. I realize you may not even wish to comment. Do you have any recommendation as to how we might awaken or in

some way snap the people—and I am referring to us here in Congress and the Government, which after all is all the people—out of this sense of complacency and bring us to a better realization?

General GAVIN. Well, sir, I share your feeling about being in mortal danger which increases with each passing day. But I really do not feel it is appropriate for me to comment on what can be done about it.

It seems to me it is a very fundamental problem and there is nothing much I could add to our common understanding of that, I think.

Mr. SISK Do you understand, in order to do the things that certainly some of us feel should be done in making it possible for you and others who have knowledge and understanding to move ahead with the rapidity which we feel necessary in this field, we, of course, must have the national backing, the backing of all the people? Of course, that is where it becomes essential, seemingly, to me, to awaken everyone from this sense of complacency. And yet, frankly, it seems hard to pin it down as to what we must do. Heretofore, it has been necessary to wait until the bombs are dropping before we snap out of it and we begin to do some things. With the things we face now, that will be way too late.

General GAVIN. Yes; in fact, I think the electorate is ahead of the Government. The people are ahead of the Government. They are more concerned than the Government is.

Mr. SISK. I appreciate that statement. Maybe we here are more asleep, in your opinion.

General GAVIN I say it not because it is the thing to say, because I think Congress is a better barometer of the situation than any other branch of the Government. Congress is more concerned, I would say, than any other branch of the Government. I have been out to the people in the last few weeks. The questions they ask are penetrating and the people are concerned and quite worried.

Mr. SISK. I have one other line of thought, General Gavin, and that has to do with what I would call the arsenal type of research and development program as against the 100 percent contract type of a weapons program. I do not know whether I make myself clear.

General GAVIN. I know what you mean.

Mr. SISK. Will you comment on that? That is of some considerable concern to me, and I know it is to some other people because they have asked me about that.

General GAVIN. I will comment on it and say that I have given that a great deal of thought in the past 4 years, particularly since I have been associated with the arsenal system intimately and with other systems. We have talked about the subject exhaustively. It would appear at first glance that if this country is to survive only the most intimate association between our armed forces and industry would enable us to survive and if American industry has the drive, the energy, the imagination that it professes to have, if it can make these television sets, big fendered automobiles, all the plastic things that no one else in the world is thinking about, surely, therefore, it has all the energy and imagination to push ahead in military programs if adequately funded, and therefore, if the competitive system, which is the essence of our democratic system, is going to compete favorably with the totalitarian government only the most intimate association of the armed forces and industry will enable us to do this.

This appears to be a very valid argument. Unfortunately, it does not stand up because the very features in our system that cause competition are the very things that keep the armed forces from moving ahead. Specifically I mean that if the armed forces became so close and totally embraced by a particular industry, soon they find themselves buying things that are obsolescent that they don't need, they cannot shake it off. They find themselves buying things that were long ago obsolescent because industry wants to sell them.

Industry urges that they be bought. They put out attractive brochures to advertise them. Soon you find the services buying things that they are forced to buy, practically. The visionary in the service, the military scientists, the people that see the future, who say it is wrong, cannot shake themselves loose from the system they themselves have gotten into and the thing they themselves have brought about The advantage of the arsenal you see is the defense parameters. It does not have to compete with industry. In most cases it does not It has parameters and it calls on scientists for advice and it knows what it requires of a certain amount of national product in certain fields.

It evaluates what industry gives it. It advises our military service as to the direction in which it should go. Then they can go and get what they need. The arsenal therefore gives you a degree of independence from industry that is essential to shaking off obsolescence and achieving innovation from time to time. So there are advantages in the arsenal system despite the first argument I gave you which seemed to establish the point that only the most intimate association with industry and service and rejecting the arsenal system is best.

I don't believe it is. The answer? Well, we need a reasonably controlled arsenal system You need some way to assure that the taxpayer gets his dollar's worth for the dollar spent. You need, too, the main reason, the closest association between the service and industry. There is no black and white simple answer to the problem. Certainly the answer is not to reject the arsenal system. I would not do it.

Mr Sisk I appreciate your comments very much. I have felt, and I may be wrong in this, that to some extent we have seen demonstrations of that in what the Army has been able to do at Redstone with the Redstone and Jupiter C as compared to a great deal of money that has been poured by a contractual arrangement into some other systems which, unfortunately, have not developed.

I certainly, of course, am all for American industry. It has tremendous powers of production, particularly the assembly-line type. That is where my concern comes in. Do we get so involved in the desire for assembly-line production when we are in a field here where every day you make some new discovery and the need to make minor changes or make changes can only be done in the arsenal-type operation?

General Gavin Yes The development of the Redstone, the Jupiter C and the Jupiter, are illustrative, in my opinion, of good management of an arsenal because the Army is not producing those missiles, as you know. They are being produced by industry, Reynolds Metals, Chrysler, Ford Instrument, and so on. I must say without pointing a finger to any specific individual or any industry, I worried frequently during the past couple of years lest unfavorable

decisions coming to the Department of the Army did not in fact reflect industry pressure on our Government, on the Department of Defense.

You see what you end up with. You have thousands of employees in areas who must be continued in employment and industry cannot simply be chopped off with this expensive unemployment resulting. Yet, you cannot continue to support them if the product is not worthwhile and if it is only going to lead to military disaster in the long run. And yet I felt that the industrial pressure upon decision making processes were unfavorable to Redstone Arsenal despite the good hard work it was doing on a very austere basis to come up with the end product we needed but it is a situation with which we must live. I see no easy way out of it.

Mr. SISK. I have one other question. You are probably familiar with this question because it has been tossed around in the past 2 or 3 days. Do you agree with Dr. Von Braun and General Medaris that there are specific objectives, important objectives, to be gained from a project which would place a man 150 miles into space, something similar to what was proposed by Dr. Von Braun the day before yesterday. It was mentioned by General Medaris under questioning today?

Or do you in turn agree with someone else who indicated it was just some sort of a stunt and did not have an importance?

General GAVIN. Like shooting someone out of a cannon?

Mr. SISK. Yes.

General GAVIN. They both have something in common. You have a great source of energy which tends to cause the human to defy gravity for a short period of time, but at that point they depart because humans are not going to travel by being shot from cannons, but they are going to travel in missiles. We have to learn to walk before we run. The problems of housing a man through this experience, as brief as it may be, will contribute in the long run to using manned missiles. I see nothing but good coming from it. So I am inclined to go along with it. I agree it should be done.

Mr. SISK. Thank you.

Mr. BROOKS. Mr. McDonough.

Mr. McDONOUGH. General Gavin, I got the impression from your answer to the red tape and the problems that we are facing in carrying on this program that it is more difficult to make progress under a democractic form of government than it is under a dictator form of government. Do you agree with that?

General GAVIN. It depends on what you mean by progress. I would not say that is so at all. We have our problems, of course, but they are symptoms of a very healthy condition beneath. A totalitarian form of government makes quickie decisions of course and can make quicker bad decisions, too.

Mr. McDONOUGH. You think we can compete in a democratic form of government?

General GAVIN. Yes, absolutely. We need more tolerance of new ideas and people with new ideas.

Mr. McDONOUGH. You also stated that you thought it would be a wise thing to have a scientist in the cabinet?

General GAVIN. Yes, sir. I have thought about this quite a bit. I have been of the mind for some time that this is so.

Mr. McDONOUGH. Would you not qualify that by specifying what kind of scientist? After all, science covers a tremendous field. You are talking about a physicist, a type of man that knows something about, well, space technology, what we are talking about?

General GAVIN. Yes, I would. He would need to be more of a managing scientist or a scientist himself but he should understand the broad field of science and understand handling scientists, which is something in itself.

Mr. McDONOUGH. Don't we have such a man in Dr. Killian?

General GAVIN Perhaps we do. In fact, this is what he is in a way, although he is not a Cabinet member.

Mr McDONOUGH. That would not add to his ability at all by putting him in the Cabinet.

General GAVIN. Not at all If he would sit as a member of the cabinet and have all the authority to contribute that a member of the cabinet has, he might be better than if he were actually contaminated by too much political association, in the Cabinet as a Cabinet member.

Mr. McDONOUGH. What was the word, "contaminated"?

General GAVIN If you will forgive the word "contaminated."

Mr. McDONOUGH You also stated some time back you and Von Braun and General Ridgeway talked about space exploration and development and your ideas were canceled out by an assistant secretary of Defense?

General GAVIN. Yes, sir We were in the original Orbiter program and finally a DOD committee came up with the Vanguard solution and we went along with that. We merely reclaimed it from time to time in writing, asking that we be allowed to go ahead.

Mr. McDONOUGH Who was responsible for the cancellation of the Orbiter project?

General GAVIN. I am not sure that anyone can say one man. Of course, the Secretary of Defense is the man responsible for all in the Department of Defense, but I cannot say.

Mr McDONOUGH What year was that?

General GAVIN We first started with the Orbiter program and then you see a committee was appointed, the Stewart Committee under Dr Stewart, to consider all satellite proposals because other programs were then brought up by the other services.

The committee came up with recommendations that went to an assistant secretary of Defense who I believe—this should be certified at the time—was Mr. Quarles. Then of course his decision was supported by the Secretary of Defense

Mr. McDONOUGH The Orbiter program was canceled out in favor of Vanguard?

General GAVIN. That is right.

Mr. McDONOUGH. If you had proceeded on the Orbiter program, do you think you could have had a satellite in the air before Vanguard put one up?

General GAVIN Yes. If we had been allowed to use the Redstone main thrust machinery, yes.

Mr. McDONOUGH Do you believe, in the situation we are in now, in pushing ahead with this program, that we ought to have one line of command rather than a diversification of ideas from two or three bureaus or departments?

General GAVIN. You have one line of command and a diversification of ideas. By having it as proposed under a commission, underneath that you could have a full diversification of ideas.

Mr. McDONOUGH. But you would have one person making a decision that we are going to do this and we are going to proceed to finish it?

General GAVIN. That is right.

Mr. McDONOUGH. You think that is the way it ought to be?

General GAVIN. It is sound in business and I think it is sound in military business, too, hold one responsible for the job.

Mr. McDONOUGH. Your interest in space technology and space military techniques goes back to the early stages of our development in this country?

General GAVIN. Yes, sir; I would say so.

Mr. McDONOUGH Do you think that the stimulus for satellites and space travel in Russia was stimulated by their capture of German scientists following World War II, or did it precede that?

General GAVIN. I don't think so, very much. They have a record of scientific curiosity, let us say, going way on back. They have turned up some fine scientists and creative thinkers in past years in other fields, and I think it was a normal thing. What the Germans contributed to it I am not sure; probably not a great deal.

Mr. McDONOUGH. You do not think we are proceeding as fast as we should at the present time?

General GAVIN. When I last was associated with the program we were not, no, sir.

Mr. McDONOUGH Are we now?

General GAVIN. I don't know, but I doubt it.

Mr. McDONOUGH. That is all, Mr. Chairman.

Mr. BROOKS. Mr. Fulton.

Mr. FULTON. I am glad to have you here, General. Do you think there should be a separate command structure within the various services leading up to the Department of Defense for this type of space development and missile work?

General GAVIN. No, I don't see any need for that.

Mr. FULTON. You see no need, then, for a separate command structure in the various military services that would have access directly to the top without going through the various echelons?

General GAVIN. No. The word "need" is very important in that question. I see the need. At the moment it is rather new. Like all new things it has to be done this way, but in time, space in the military service will become as normal as missiles and airplanes and nuclear affairs are now. I do not see the need for a special organization. The word "need" is important again.

Mr. FULTON. The Russian system is now headed by a Deputy Minister of the Presidium who is a general, General Kitinov. Do you think it should be in our setup, because that has been so successful, headed by a military command rather than a civilian command?

General GAVIN. No, a civilian command, a civilian agency rather than command.

Mr. FULTON. When the setup is proposed by you, that a scientist be put in the cabinet as a separate department with a civilian cabinet head, would that mean that the research and development of space

and missile programs would be taken out of the military organizations, as such, and put over under his lead or management?

General GAVIN. Well, sir, may I say that I did propose that in answer to a question whether or not I thought it was a good idea. I said I thought it was, and that is a little different. Now I think it would be well to have a scientist on the cabinet level close to our executive. There is no implication in such an undertaking of the service losing their own scientific program or control, either. I do not see this at all.

Mr. FULTON. You would then continue ARPA as it is right now?

General GAVIN. Yes, I would.

Mr. FULTON. Would you have a firm statement in the legislation that would restrict ARPA to definite military projects and programs?

General GAVIN. Of course I am reluctant to answer that question in isolation, not knowing what else you are considering in this legislation. But as I understand ARPA, it is military and should be preoccupied with the military problems to the exclusion of others. My answer would be yes, but I would like to see the entire legislation.

Mr. FULTON. Would you have a transition period from military to civilian control that extended from perhaps 1 to 3 years, or do you think it can be done more quickly?

General GAVIN. I think it can be done quicker.

Mr. FULTON. You have said that you felt that certain programs should be speeded up. Do you think that the ion rocket, which now has a lead time of 10 years, should have more emphasis, which I do believe?

General GAVIN. I do not know what is causing it to have a lead time 10 years now. If it is inadequate funding, then it should be stepped up. If we just simply cannot see our way through to achieve the technical goals that will lead to its accomplishment any sooner than 10 years, I don't know what can be done about it, but I know it is a component of space travel.

Mr. FULTON. You think the "Old Pokey" program at Los Alamos is moving fast enough?

General GAVIN. Which program?

Mr. FULTON. Old Pokey, an Air Force rocket research program at Los Alamos.

General GAVIN. I do not know enough about it.

Mr. FULTON. Do you favor research at the present time in photon propellents or equipment?

General GAVIN. Of course.

Mr. FULTON. Do you think a research program on a photon rocket or a missile or a space vehicle is practical at the present time?

General GAVIN. Yes At the present time it is entirely theoretical and yet by dealing with the theory we will soon be able to put in more finite form what such a propulsion system will look like and as soon as we can apply it in space we should go right on with it. To me this is very much a part of the space program and should be given as high a priority as anything in the space program.

Mr. FULTON. Is there enough emphasis being put on propellents and the development of the various categories of propellents, liquid and solid, or would you emphasize one over the other at the present time?

General GAVIN. Well this, much like the other question, in a way is difficult for me to answer because I am not sure specifically what is being done now. When I was working in the rocket business and missile business we were having great difficulty getting funds to do anything other than specifically approved projects which were at the time the Redstone and Jupiter and the Jupiter was being funded out of the other programs in the Department of the Army, anyway. So you were reluctant to push more work because it took money away from other programs.

At that time we were trying to get a solid propellent midrange missile underway and that took quite a long time to do So at the time I disassociated myself from these programs, actually about 6 weeks ago, I felt we were not doing enough. They may be now, I don't know.

Mr. FULTON. Would you tell us how you feel about the various programs that are now in progress? Are they getting adequate funds? Are they under pressure of urgency or are they moving along at an ordinary pace? When you were leaving, weren't you discouraged about the fact that they were not moving fast enough?

General Gavin. Of course I was. We could not get our satellite up and when we finally under the urgency created by the launching of the Sputnik, were again put in a position of making proposals, these proposals just rested week after week, month after month, without action. I am not sure but there may be some still around, I don't know, such as reconnaissance satellites, and like that. Yes, we were not responding quickly at all. The decision should have been made in hours to get the work underway. As I say, some may still be waiting to be made. I know some of them were not made for quite a long time. I am not sure of the situation at the moment, however. It is improper for me to say anything critical about them.

Mr. FULTON. Do you see an urgency for a program for the research and development of a third-of-a-million-pound-thrust engine or group of engines?

General GAVIN. A million-pound thrust?

Mr. FULTON. A third of a million.

General GAVIN. A third of a million is as fast as we could go.

Mr. FULTON. How about a third of a million that General Medaris spoke of at a cost of $50 million?

General GAVIN. I hope General Medaris is working on a third-of-a-million-pound-thrust unit now I talked to him about that in November and suggested that he get to work on it and scrape up a few odd pennies here and there down at Redstone Arsenal. We should have been miving on that before this.

Mr. FULTON. If you were given all the equipment necessary, the necessary scientific talen and research, as well as the facilities, and were given the word to go ahead on an urgency basis, how long would it take for you to take a shot at the moon?

General GAVIN. Again, the last time I discussed this with my people and with the scientists was about 90 days ago and at that time, given approval, we felt that we could do it within a year. Now, only from what I have read in the press, authority has been given to get the program underway, so I should say within a year we should expect results.

Mr FULTON. Do you think it would be a good move for the United States to have an urgency program for a lunar shot?

General GAVIN Unquestionably, yes, we have to.

Mr FULTON May I finish with this?

Do you think it is immediately necessary to institute programs to have nuclear propellents for rockets, missiles and space vehicles? Should we move at once into that field on a broad base, nuclear propellents, that is?

General GAVIN. Yes, surely You realize we are getting around the edge of rather classified programs, but of course there is a tremendous power source there For the investment you have to realize considerable range and considerable efficiency in lift, so it suggests perhaps beyond the chemical propulsion system and we should, as a matter of priority, go after the nuclear propulsion systems

Mr FULTON So this committee should make such a recommendation in its findings, in your judgment?

General GAVIN I would certainly recommend that.

Mr. BROOKS. Mr Keating.

Mr KEATING. Pursuing the questioning of the gentleman from California, Mr. Sisk, about complacency in this country, a very nice lady wrote me and said, "I see you are on the House Space Committee Don't you have enough problems on earth without getting up in space?"

Undoubtedly others have gotten mail like that. How do you answer that?

General GAVIN I would answer that this way: We have enough problems on the earth, but for the first time we can see through the potential of knowledge that exploration of space affords us, a way of solving the problems on earth, because I am convinced that through an adequate family of reconnaissance satellites, communication satellites, all under good management, and made available to an international agency such as the United Nations, we could prevent the outbreak of major conflagrations. You will never be able to keep some people from shooting at each other, no more than you in individual cities today keep individuals from engaging in little fracases, but the major ones can be brought under control. So I can see in the space program for the first time a clear possibility of lasting peace.

Mr KEATING. Thank you very much, General. I will send a lot of my correspondence to you for answering.

Pursuing another question, he asked about this pooling of information with our allies. I share your views that we should go further in that respect and I think the President has recommended it. However, I have had a study made by the Library of Congress and I have asked them to study the laws of other NATO countries as to the protection which they give to secret information. Some of them have almost no such laws, others have laws rather comparable to ours, and others have something in between. One or two have considerably stricter laws than ours

Now, you would agree that we could not share all our secrets with even our NATO allies, would you not, or how do you feel about it?

General GAVIN. Well, of course, there are certain things vital to national survival of them.

Mr. KEATING. I wonder if we should get to the point of this committee, as related to space problems, of making some recommendations in this regard? How do we get around that difficulty? Do we do it by some international accord of some kind? Do we ask our allies to strengthen their laws? I would hesitate, much as I feel we should pool more, much as I realize we would benefit from other countries by such pooling. I would hesitate with 2 or 3 of our allies to do that because of the complete lack of security laws on their statute books. Have you any suggestion as to a way around that?

General GAVIN. Hardly in useful specific form. I would reiterate once again my concern with the lack of up-to-date technical knowledge in the, let us say, military establishments of our allies. I have found in association with my colleagues from other countries and talking to them about the meaning of missiles, the meaning of nuclear weapons, tactical nuclear weapons, so often their thinking is almost exactly in a pattern matching ours of 5 and 10 years ago.

Yet I was not in a position to say more than just I thought you really ought to look at it this way, or that way. You finally have a condition of obsolescence in your military establishments of your allies which you see you cannot do anything about and this engenders a lack of confidence on their part, too.

We have this in Europe today. Perhaps through the NATO we could bring together the heads of government to form a committee within NATO to take a look at this and come up with a solution to it, but we must solve this problem. In fact, I am inclined to think now we are keeping things from each other that the Soviets know anyway. So this gets to be quite silly.

Mr. KEATING. I presume, then, it is true in some instances; probably in others it is not true. It has been a matter of considerable concern to me, sharing the view you have. But realizing the impediment created by foreign laws, it is a very difficult problem.

General GAVIN. Yes. You know, it really is. There is a considerable duplication, too, you know. If only the British could do one thing and we could do another, and the French another, maybe one would do electronics and radar, the other nuclear weapons in a certain category, and others in certain missiles, we would be much better off.

Mr. KEATING. There would be better savings.

General GAVIN. Yes.

Mr. KEATING. Lest there be any misunderstanding arise from a question put by the gentleman from Louisiana about Redstone Arsenal, the question was "Would you make changes there?" Let us get this pinned down.

You would not relieve General Medaris or Dr. von Braun, if you were in authority to do so, would you?

General GAVIN. No.

Mr. KEATING. I have been down there and I have been greatly impressed with the work of both those gentlemen.

Mr. BROOKS. May I say to the gentleman I don't want that inference drawn from my questions.

Mr. KEATING. I am sure that the gentleman did not intend that. But I wanted to get that very clear, because I was tremendously impressed with the work they were doing and the sense of urgency.

General GAVIN. Yes, they are doing a grand job.

Mr KEATING. Don't you think the sense of urgency is present there at Redstone?

General GAVIN It is certainly present there.

Mr. KEATING The chairman asked you to make some suppositions about the rate at which we have moved or could have moved. Let me ask you this, and see how close you come to the opinion of one of our other witnesses. If we had moved in this field like the Russians apparently did right after World War II, when would we, in your opinion, have had a satellite up?

General GAVIN. I would say perhaps about late 1953 or so.

Mr. KEATING. One of the other witnesses said 1951 or 1952. You would put it probably in 1953?

General GAVIN. Yes Who was it that said 1952?

Mr. KEATING. General Putt, I think.

General GAVIN. I would say Dr. von Braun would have a better idea. The state of propellents and the guidance systems and so on, component availability, there are so many factors that enter into this, I am not sure we could have gotten it up much sooner than 1953, but perhaps we could have

Mr. KEATING I want to ask you one or two questions about this proposed bill which is before us In the sentence which was read to you on the first page, the second sentence, it states

> The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations in which case the agency may act in cooperation with or on behalf of the Department of Defense.

I envision that that sentence, and I think a comparable one which appears later, may be the subject of a good deal of discussion here in our committee when we get to writing a bill. That troubles me a little. I certainly share the idea of a civilian agency here, but I do not want to do anything to interfere with military operations in this field as they now exist or may hereafter exist

I wonder if we should not, for one thing, make it mandatory upon the agency to act in cooperation with the Department of Defense. Then, how do you interpret those words, "on behalf of the Department of Defense"? How would this agency act on their behalf?

General GAVIN I would presume that if the Department of Defense had something it wanted done the agency could act for it and undertake specific projects for it at its request

The language lends itself to a lot of bickering later on as it is now worded.

Mr. KEATING. That is what I was afraid of. I wonder if we should not try to pin that down a little bit, with a little clearer delineation of the proper missions of the two

General GAVIN. Yes. I would say it would be well worth while to ask the Department of Defense people, who are going to have to carry out this, what they think of it, what it means to them. But it should be worked over very carefully. It is a little too ambiguous now.

Mr. KEATING. I want to ask you about another provision of this bill. You had some discussion with one of my colleagues about the full-time or part-time character of this board. Now the board as set up in the bill is generally advisory in character, but in section 5 it sets up certain respects in which the board must be consulted by the

Director and those four areas are pretty broad. You voiced the idea that, perhaps at the outset, it should not be a part-time arrangement.

I have an open mind, myself, on that subject. Perhaps they should meet oftener than four times a year.

General GAVIN. Yes.

Mr. KEATING. If it were a full-time board or if men were devoting their full time to the activities, you would not recommend then a 17-man board, would you?

General GAVIN No, I would not think so.

Mr. KEATING. Have you given any thought to the size of it?

General GAVIN No, I really have not.

Mr. KEATING. But it should be substantially fewer than 17.

General GAVIN. Yes, 17 on a full time basis would be definitely a debating society

Mr. KEATING. That is exactly it.

Now just a couple of things more other than that. We have had quite a little difference of viewpoint or difference of approach here in our efforts to define outer space. Do you look on outer space as an area substantially different in kind from land, sea, and air, or just different in degree from air or atmosphere?

General GAVIN. Difference in kind and difference in degree, both.

Mr. KEATING. In other words, one witness drew a parallel in defining the atmosphere in the outer space with the sea, pointing out that there were different areas of density in the sea. I personally rather differ with that viewpoint I said to him it looked to me more like the difference between land and sea than the areas in the sea. Which of us do you think is closer to your thinking?

General GAVIN. I think it would be the one you don't like because by common usage now outer space has come to mean that area beyond where any substantial portion of the gaseous envelope about the planet exists, that is beyond the atmosphere. Then you are entering outer space. How far beyond that you want to go I do not know. Actually, by common usage there is so much talk about the planetary system or solar system as being outer space and then the galaxies are considered almost another order of magnitude beyond.

So I would be inclined to consider the area from beyond any substantial portion of the atmosphere remaining to include the planetary system of which the earth is one

Mr. KEATING. You would look upon that not only as a difference in degree but in kind?

General GAVIN. Yes, sir

Mr. KEATING. Now that leads me to this military question: Do you not feel that there should be a complete definition of the missions of our three services, if for no other reason, in the light of these space developments and because space might be the principal battleground of the future?

General GAVIN. Well, sir, space and the attendant problems are not an isolated phenomena of our time. It is part of the nuclear missile age. The significance of the sum total of all of these things is that the earth has shrunk to a very small size, physically, for combat purposes to the military man This implies at once a redefinition of roles and missions and redefinition of ways of exercising commands so as to achieve objectives in war. This more than space itself.

Mr. KEATING. But a redefinition of roles and missions in contemplation of their objectives, rather than where they ar to perform?

General GAVIN. That is about right, yes. I agree that is right. You could of course say the objectives in terms of tactical objectives and organizational structure they redefine those terms

Mr. KEATING. Because now the roles and missions are defined in terms of land, sea, and air.

The media in which they operate now all overlap and any service has a weapon that will involve exploiting media of all three, land, sea, and air, so obviously they overlap.

Mr. KEATING. Thank you.

The CHAIRMAN. Mr. Ford.

Mr. FORD. General Gavin, it has been my good fortune to have some contact with the Army's research and development program for the last 6 years No one has to sell the Army research and development program today I think the record speaks for itself It has been spectacularly successful. At the same time, I know your close association with it the last 4 years. I know something of your frustrations over the last 4 years even though, under your vision and leadership, it has grown within the Department of Defense with a budget of something below $30 million per annum to a budget now, as I recall, in the area of $150 million in fiscal year 1958. It is my opinion that through your vision and leadership the Army research and development program has really done a most effective job. I know that all during this period of time, some 4 years, you have felt that more funds, more programs should be available to the research and development. The frustration of trying to convince the Department of Defense, the Bureau of the Budget, and the Congress, must have been a difficult time as far as you are concerned. I just feel that everybody in the Congress and the public should recognize your magnificant contribution to our success in this area.

Now, one of the things that Dr. von Braun said when he was before the committee several days ago was that a significant breakthrough in the Redstone program in 1954 was really the thing that made a satellite feasible. Was that the breakthrough in the main thrust program?

He did not indicate precisely what he was referring to, but he indicated a breakthrough in 1954 resulted in the practicality of a satellite.

General GAVIN. Yes I would say that probably was in 1954. We had then to make a basic decision whether or not to drop a missile known as the Hermes, which had no growth potential, or go to the Redstone which we saw had a tremendous potential based upon the 75,000-pound-thrust engine. At that time we went for that. I would presume it was that because at that time there was no other significant change in prospect in what we were doing but that thrust looked good then and it paid off In fact, late in 1954 we decided we could do an IRBM, 1,500-mile missile.

Mr. FORD He also indicated that this breakthrough was something which would have followed automatically, if you had undertaken the Redstone program at any point following, we will say, World War II.

General GAVIN. Yes.

Well, again, he would have to answer for himself on that.

Mr. FORD. To turn to a question which has bothered me, because I am greatly concerned that we have no impediments placed in our weapons programs, I would like to refer to the language which has been discussed earlier, that which discusses language in the proposed bill.

To quote the language again:

Except insofar as such activity may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with or on behalf of the Department of Defense.

I think we ought to recognize, first, that that is a statement of policy and not necessarily the language which directs the program. Has there been any impediment in this program with the ARPA setup as far as weapons and weapons systems are concerned?

General GAVIN. None of which I am aware of but it could well be that I would not be aware of them

Mr. FORD. ARPA could be a sort of forerunner of this agency since it has both control over the space programs that we have now in the three services and, to some degree, the weapons program as they relate to the service projects But there is no indication as far as you know that there is any impediment in the programs with the ARPA setup?

General GAVIN None at all. I must say I share your concern. You know, the really great obstacle we say has been decision making of a bad quality but those decisions usually have been to direct artificial limitations being placed on the program and looking back on this you don't understand how they have been able to tell any service, whether the Navy or Army or Air Force when they have a potential to contribute to national defense, you may not examine this or that, you may not research there, these things are incredibly harmful to the national interest. How they occurred I don't know, but they are no phenomena of our times. It has been the usual happening in the past. There must be absolutely no impediment caused by selfish industrial or any other interest in these programs. They must move ahead more freely than in the past.

Mr. FORD. Do you feel the proposal to have at least 1 person out of 17 on the advisory committee from the Department of Defense is adequate representation for the military in this kind of area?

General GAVIN. At this time, with that number, I would be inclined to think more. You would do better with more because a great deal of the competence in this area is now in the military service. I would suppose the composition of that committee could be changed later.

Mr. FORD Just to have enough people there who are knowledgeable in this area to make these decisions?

General GAVIN. Yes, I would say so.

Mr. FORD. Would you go to the extent of one from each service?

General GAVIN No, I would not ask the Department of Defense to appoint a certain number and I would not state what service they came from.

Mr. FORD. Civilian or military, representing the Department of Defense.

General GAVIN. Yes.

Mr. FORD. Not representing a service viewpoint?

General GAVIN. Right. This transcends that.

Mr. FORD. That is all, Mr. Chairman.

The CHAIRMAN. Are there any questions from any other members?

Mr. McDONOUGH. I have one question, Mr. Chairman.

Is the present rocket and missile thrust principle that is being used amplification of the original studies of Dr. Goddard?

General GAVIN. Yes.

Mr. McDONOUGH. Of course that is a principle that sufficient power will shove an object straight up from the earth?

General GAVIN. That is right.

Mr. McDONOUGH. Has anything new been discovered that Goddard did not know?

General GAVIN. The fundamental principles that Goddard wrote up are being applied worldwide.

Mr. McDONOUGH. Are the same principles being used by Russia as well as the United States?

General GAVIN. To the best of our knowledge, yes.

The CHAIRMAN. I do not know whether it has been covered, General. I had to be unavoidably absent because I am presiding over the House and I had to be there to appoint a committee to attend the funeral of the late Senator Scott. I could not designate somebody to do it, I had to do it myself as Speaker pro tem, otherwise I would have been here at 2 o'clock.

You have been associated with the space program going back to the days when Mr. Stevens was Secretary of the Army. Is that correct?

General GAVIN. That is correct, sir.

The CHAIRMAN. That was when you first proposed a satellite launching.

General GAVIN. That is correct.

The CHAIRMAN. You have taken an increasing interest in it ever since, dedicating yourself, your talents, your ability, and your experience to the consideration of this important aspect.

General GAVIN. Yes, sir, among other things.

The CHAIRMAN. You have certainly come to some conclusions as a result of your studies and your experiences.

General GAVIN. Yes, sir.

The CHAIRMAN. What significance do you attach to the present satellite situation, first from a civilian angle?

General GAVIN. I know this committee has had these points brought before it, sir. They are rather well known now.

We have the obvious one of weather, weather control, worldwide communications, not only electronic transmission of communications in written form but worldwide communications in television programs and like that. Those are the very obvious things.

The things we do not know about we will not really know about until we get into outer space, that have to do with what we find in outer space, new fuels, propulsion systems, the reaction and behavior of the human being. He may well be able to contribute to his own longevity.

These are the things that I am curious about.

The CHAIRMAN. Is it fair to say that, from a civilian aspect for the long pull, you think it is a matter of the greatest importance?

General GAVIN. No question about it.

The CHAIRMAN. Now, from a military aspect, what is your view as to the present satellite situation and the necessity of entering into it

and projecting our activities, pursuing our activities from the military angle?

General GAVIN. Of course, as I have said, it is the most significant thing of our time, militarily.

I feel rather strongly that it is a reconnaissance vehicle, first of all from the military point of view, and thus becomes part of an ICBM system. It is a reconnaissance vehicle that in time will be so refined and sophisticated in performance that it will be able to contribute such information of such an accurate and detailed nature that it in turn can be used as a target, acquisition target survey for an ICBM system.

If manned aircraft can no longer deliver firepower in combat they can no longer do reconnaissance

A satellite is, therefore, in my opinion, the reconnaissance element of an ICBM system in time.

The CHAIRMAN. Do you have some views on cosmic ray activity, too?

General GAVIN. Yes, sir. Of course, we want to understand the phenomena and the density and so on and we are getting data from Explorer on this now.

The CHAIRMAN. It is important to find out about meteorites and their effect on the satellites and space vehicles.

General GAVIN. Yes, sir, we are getting data on this, too. I believe that the Jet Propulsion Laboratory discovered the meteorite situation was not as bad as we thought it would be. Now an understanding of this will, of course, go right back into the problem of space travel itself because we will know the problems we have to deal with.

The CHAIRMAN. What about the transmission of the electromagnetic signals?

General GAVIN. You see, one of the great problems we have is defense against an ICBM, antimissile missile defense.

It is a very, very challenging problem.

Of course, we must acquire an object far out in space and track it accurately and the transmission of the image, let us say, of such an object through space goes through distortion and by being able to track a satellite physically, accurately track it, we are learning the first thing about tracking an object that will ultimately be and will probably be a missile warhead coming in, by using radards to reflect electromagnetic energy from that and receive the image of what we see through the ionosphere which distorts the image, depending on how you look through it, the angles at which you look through it.

By dealing with these problems, you learn the answers to the questions you have about the antimissile missile defense of the country.

So by participating in the space program and all the associated problems of control, tracking, and so on, you at once improve your defense readiness in the antimissile missile period.

The CHAIRMAN. Has there been any projection of consideration into electronic communications around the earth?

General GAVIN. Yes, this has been proposed. I know that it was in the paper released by the White House on 26 March.

Industry has proposed this and it appears quite sound. As you know, our surface communications problems on the earth are difficult. They are difficult to maintain. In fact, I remember reading a state-

ment to the effect that it would be simpler and easier to communicate with Mars rather than to communicate with Tokyo because in the former case we would have no atmospheric problems to contend with.

By putting satellites in a predictable orbit—you might have to control them after you get them out to get them exactly in the orbit you want—you can use these as vehicles to carry communications. They can play the communications back on being triggered, play them back automatically, and it would be possible to put a family of satellites in orbit that could fly over Tokyo, Washington, Paris, on schedule, picking up communications and playing them back.

From the viewpoint of industry, it will probably in the long run cost a lot less to communicate that way than it would be by maintaining very costly surface communications systems and requiring high energy to transmit, and so on.

The CHAIRMAN. We have had plenty of evidence about the known ability to send a family of satellites into orbit a considerable distance from the earth. Some testimony has been twenty-five or twenty-six thousand miles out.

General GAVIN. I really believe you refer to what is sometimes called a stationary orbit. That is putting a satellite in orbit at exactly the right distance so that it maintains a stationary position, vis-a-vis a point on the earth. This would mean launching it in orbit and adjusting it in orbit. There should be power aboard to enable it to kick itself a bit around and finally you get it at a place where you want it and then, as the earth rotates, it rotates with the earth.

By a satellite such as that located within range of Washington and another one within range of Moscow and another one within range of Tokyo, these could play back and forth to each other communications, television programs, or what not, and be merely relay stations completely encircling the earth.

The CHAIRMAN. It could be a worldwide communication network.

General GAVIN. Yes

The CHAIRMAN. Also a television network.

General GAVIN Yes, indeed. That appears possible.

The CHAIRMAN. Also, is there a proposal to launch a satellite that would give comprehensive photographic coverage of the earth?

General GAVIN. Yes, the reconnaissance satellite should do photography in time.

The CHAIRMAN. That is important?

General GAVIN. Absolutely.

The CHAIRMAN. You would have a pretty good coverage of the earth or any particular part of it?

General GAVIN. That is right

The CHAIRMAN. Within a comparatively short period of time?

General GAVIN. Yes.

The CHAIRMAN There are some, and I would like to ask you if it is your opinion, that believe if that were perfected it might make a marked contribution toward conditions that would prompt recalcitrant nations to enter into peaceful relations with other countries.

General GAVIN I would hope so. Those whom I have talked to feel that way about it.

The CHAIRMAN. Is it your opinion that the accomplishment of that would be a major contribution?

General GAVIN. Yes, sir.

The CHAIRMAN. And it could be done?

General GAVIN. Yes, sir, we believe it can be done.

The CHAIRMAN. Have you an opinion as to the period of time in which it could be put into practical operation?

General GAVIN. Yes, sir. I would say that if given adequate funding now we would be doing rather primitive photography in about a year and perhaps a year later doing accurate photography under good control conditions.

Mr. McDONOUGH. General Gavin, if we were capable of putting such equipment into orbit and the Russian Government knew that we were going to obtain this vital information from them, would we be involved in a military situation?

General GAVIN. Yes, we would.

Mr. McDONOUGH. How soon did you say that we would be capable of putting this kind of equipment into operation?

General GAVIN. I might say this problem is not a simple one at all. The satellite is perhaps the more simple of the two main sets of equipment, the ground and the space, the processing of these vast number of photographs on the ground, handling them and so on, would be a big thing, a very difficult problem.

If given adequate funding now, my estimate would be that by the end of the year or approximately within a few months we might be able to do some primitive photographic work and about a year later we would begin to show results that were somewhat sophisticated and we would refine it as we went along. Within 2 years we should be able to see reasonably good results.

Mr. McDONOUGH. If the Russians are far enough advanced at the present time, ahead of us, and are prepared to put such equipment into orbit, would we have any means of deterring them at the present time?

General GAVIN. No; none at all.

Mr. BROOKS. Would we have any right to deter Russia?

General GAVIN. Yes, sir, we would. Intrusion of our air space is something that we should decide is right or wrong.

Mr. BROOKS. That is not air space, that is space space.

General GAVIN. That is right. Intrusion of our space, we will say then.

Mr. McDONOUGH. We were discussing that the other day. Of course, if a manned aircraft came over the United States at 50,000 feet, we would attack it immediately, would we not?

General GAVIN. I would presume so; yes, sir.

Mr. McDONOUGH. Is that not the present mission of the aircraft, an unfriendly or reconnaissance plane?

General GAVIN. That is right.

Mr. McDONOUGH. If it came over at 100,000 feet, could we attack it today?

General GAVIN. Well, sir, very soon we will come very close to having that capability.

Mr. McDONOUGH. If it came in at 200,000 feet——

General GAVIN. No.

Mr. McDONOUGH. They would be invading, you think, our territorial rights?

General GAVIN. In my opinion, they certainly would.

Mr. McDONOUGH. Where do our territorial rights go to in elevation?

General GAVIN I do not know that you can give a definition such as height and elevation because soon you get out beyond the meaningful terms. Euclidean geometry says to have meaning after all and you get into something else.

It seems to me that if the act in itself is of potential harm to our Nation and endangers our security, then it is invading our territory.

Mr McDONOUGH Do you think that Sputnik No. 1 was harmful and invaded our territory?

General GAVIN Well, sir; I do not think so, but I am not sure about it either When we saw this coming last June and we knew that our satellite would not be up, this very problem came up for a great deal of technical discussion.

I asked my deputy to go down to talk to Dr. von Braun and General Medaris and see if we could not develop a satellite interceptor. I felt like the young man at Pearl Harbor who saw the Japanese airplanes coming and he called the attention of his superior to it and he was told, "We can pay no attention to it." We could see the Soviet satellite coming. It was on our scope practically. Yet we did not know what the threat to our Nation's survival would be. Possibly it could have been very dangerous We could have been confronted with a situation where active reconnaissance was taking place. We knew it. Nothing could be done about it. And all our pleas before the United Nations and everything else would gain no response at all.

So I asked my deputy to go down to Redstone Arsenal, which he did on June 21, and at that time Dr. von Braun came up with a proposal to meet our requirement. He said he would start on the program right away.

So, on October 4, I had lunch with Dr. von Braun and Dr. Shilling, which was the day that Sputnik went up. At that time I checked on our progress and we had some pretty solid thinking on it, we knew pretty well where we were going. We did it entirely on our own because (*a*), we were forbidden to launch a satellite; (*b*), we knew the Soviet was going to launch one; (*c*), we knew the country was in mortal danger, we had to do something So we started on a program of our own.

It has been a matter of concern to me at least since then. How far up is up, I do not know, but I know when our security is threatened we have to do something about it. When our survival is at stake you had better speak up and act.

Mr. McDONOUGH. Of course, we do not know whether Sputnik No. 1 was a reconnaissance satellite and we do not know what danger it was to us. However, whatever it was, they did not challenge our satellites when we shot them up. At least, they have not up to now. They have not contested the fact that we have sent up a satellite.

General GAVIN. No, sir, they have not. Of course, we have done everything possible to demonstrate that it is a purely scientific satellite as a contribution to IGY.

I might say before theirs went up we did not know it was going to be Sputnik 1 in size. If we had known that it would have been 1,184 pounds, which is what Sputnik 2 was, I would say we would have been quite concerned, because that is a big weight.

Mr. McDonough. Were we then capable of shooting a satellite into the air of 1,100 pounds?

General Gavin. No, sir.

Mr. McDonough. Are we today?

General Gavin. No, sir, we are not.

Mr. McDonough. What thrust does that require?

General Gavin. The thrust of that was estimated on the order of 280,000 pounds or so. So I would say, therefore, and I think the Atlas thrust, if finally mastered with all of the associated problems of control and so on, could give us that payload and a super-Jupiter could do likewise, I would not say "No," we could not do it. If you asked, could we tomorrow morning do it, I would say "No." I would say we are on the threshhold of achieving that thrust under good control, though.

Mr. McDonough. Up to the time you left the service, did you have any knowledge of what we can expect from Russia in their next satellite?

General Gavin. No, sir; I certainly do not.

Needless to say, it is a subject of considerable speculation. We should be concerned about it.

Mr. McDonough. And we have no means of determining through our electronic detection or other mechanical means what Sputnik 2 may have obtained in the way of reconnaissance of the United States?

General Gavin. I would suggest, sir, that Dr. Pickering and the people from the Jet Propulsion Laboratory answer questions on this subject. I have talked to them a great deal about it. We have received a great deal of data from Sputnik 2. A great deal of it is very mixed up and confusing and difficult to—not decipher but untangle, because you get a series of communications on one pass over and the next pass over you get a series again of different types of data, coded in a different manner. Then you get various permutations of these things. It was at the beginning. They may have it well in hand now

I would suggest that Jet Propulsion Laboratory answer your questions on this. They could still be getting data we know nothing about because it would only transmit to the Soviet Union and be silent over the remainder of the world.

Mr. McDonough. Thank you.

The Chairman. We have had a lot of testimony about the ability to reach the moon, hard and soft landings, but I will not go into that. What is your opinion about our ability to put something on the moon?

General Gavin I understand we have such a program finally approved now and we must go after it just as fast as we can.

The Chairman. Could you give us any idea when, if they go ahead in an effective way, that could be done?

General Gavin. I am not sure that I could put a number on it. Within a year, I would say, if we were allowed to go ahead we could go ahead with an object, a lunar probe shot, as it is called.

The Chairman. Would you say in the midsummer of 1958?

General Gavin. No, sir, I would not say that, not in the midsummer of 1958. We are practically approaching that now. If we had been given the green light last fall, we probably could have.

The Chairman. On the question of civilian-military control, you have some rather strong views, have you not?

General GAVIN. Well, sir, the civilian control is what I have supported.

The CHAIRMAN I ask this question of all witnesses, because it is a matter in which I am immediately, somehow or another, interested. I find myself recognizing the importance of things that might happen 2, 3, 4, 5 or 10 years from now. I do not like to get away from today and the immediate future.

Suppose another nation, a potential enemy of ours, had a decided advantage over us in the field of intercontinental ballistic missiles and at the same time had a good defense against our strategic air command, what position would we be in then?

General GAVIN Ours would be an exceedingly difficult position.

The CHAIRMAN. Is that beyond the realm of possibility?

General GAVIN. Not at all. It is entirely possible. I do not want to be facetious about that, but this is a subject that has been discussed very often.

In the very dynamic situation in which we find ourselves, and I referred earlier to the possibility of breakthrough from time to time, if one does not really stay on top of the situation and remain very curious and eager to make progress and keep doing things that must be done, we could well find ourselves in such a serious lag that you are being told what to do, you would be blackmailed. We would see rocket diplomacy and sputnik diplomacy extrapolated into some other kind of diplomacy.

The CHAIRMAN. I do not know of any witness that has disagreed with this or challenged it, that at least one country in the world appears to be ahead of us in the field of intercontinental ballistic missiles at the present time.

Have you an opinion on that?

General GAVIN. I think the Soviets are.

The CHAIRMAN And also in the field of intermediate ballistic missiles?

General GAVIN. Yes, I think so.

The CHAIRMAN. Have you any information that you could give us in a public hearing as to, first, if they are experimenting on a defense against our bombers and, secondly, the extent to which they might have progressed?

General GAVIN I cannot, except that they have demonstrated to us their surface to air missiles in the December 7 parade celebrating the Red Revolution last fall. The missile was rather impressive in its appearance, judging by its size, its configuration. It appears to be a good missile, surface to air.

The CHAIRMAN So we are not discussing a hypothetical question, necessarily?

General GAVIN Far from it.

Mr. BROOKS. Mr. Chairman, may I ask a question at this point?

The CHAIRMAN. Certainly.

Mr. BROOKS. You have referred a number of times to a breakthrough, General. Was not the breakthrough to which you referred an atomic breakthrough? You discussed that sometime prior to that, but was it not an atomic breakthrough that made the difference?

General GAVIN. Are you referring, sir, to the Redstone question raised by Mr. Ford a moment ago, what breakthrough was it that made it possible?

Mr. BROOKS. The development of the missile program is what I am referring to.

General GAVIN. This has applied particularly to some of the missiles of the future, breakthroughs in terms of size, yield, and achievement from a given amount of fission material. At the moment, though, my use of the word applies across the board.

One can never tell now when rather revolutionary things will be discovered quite suddenly. They can come in many forms ann many capabilities. It might be mobility, fire power, it might be i? unique forms of detection or control.

The breakthrough, as I use the word, applies to all of those.

Mr. BROOKS. It could be anything, any new scientific developmentp

General GAVIN. Yes, sir.

Mr. BROOKS. I would like to ask you this: Are we not getting into this sort of situation, that we will develop mechanically this missile and this satellite, but are we not going to be, and is not the controllin3 factor finally going to be, a biological factor?

General GAVIN. I do not know that I would say controlling, sir. Do you speak——

Mr. BROOKS. In manned missiles.

General GAVIN. Do you mean that the man will be the controlling factor always?

Mr. BROOKS. I mean the ability of a man to survive in space being a biological factor. Is that not going to finally be the controlling factor rather than the mechanical factor?

General GAVIN. Yes, sir, if I understand that, I would wholeheartedly agree with you.

I will put it this way: The man will remain the common denominator of any achievement we really make. If we are to make progress in the space program, man's adaptability to it and the ability to do something in it is the critical thing, yes.

Mr. BROOKS. Until we work out developments that will permit him to survive under these space conditions, is not the biological factor going to be the dominant one?

General GAVIN. I would not exclude achievement in space by the Soviets, let us say, as an entity of their overall military power. I would not exclude that as an achievement, that we should not worry about it simply because they have not learned to solve the biological problem, but in the long pull the biological problem absolutely must be solved because it must serve man and man must be part of the system. In the long pull, yes. But I would not overlook the possibility of serious laggardness on our part on unmanned space programs.

The CHAIRMAN. I just have one more question, myself.

How important do you consider it that we concentrate in an effective way on those activities that might be termed the "space program"?

General GAVIN. As now contemplated under this bill, where we concentrate the supervision—I have not read the wording of it—of the program under one agency, I think that is sufficient.

Where we have a decentralization of programs, a diversification of technological applications, such as will occur in the various services and the various laboratories, this is to be encouraged and sustained as it is going along, but we ultimately need one man responsible for the overall space program. I presume that he will be provided for in this legislation.

The CHAIRMAN Do you consider that it is so important that even the question of the survival of a nation or nations might be involved where some other nation had the advantage?

General GAVIN. Ultimately it could be put in those terms, yes.

The CHAIRMAN. I would like to get your viewpoint for the record as to how important you think, how vitally important you think it is for our country to prosecute known discoveries, and putting them into practical operation and pursuing further basic research for future discoveries?

General GAVIN. I would know of nothing of greater importance now than this

Mr. McDONOUGH. You are familiar with the tests that we are going to conduct on antimissile missile deterrents in the South Pacific, are you not?

General GAVIN. Yes, sir.

Mr. McDONOUGH. Is it classified?

General GAVIN. Yes; it is classified.

Mr. McDONOUGH. Then you agree with our decision not to cease the testing of nuclear weapons as requested by Russia recently?

General GAVIN. I agree with that entirely, sir. The problem, you see, is to live with it at home and to live with it you have to learn how to package it and package it in a useful way.

I think we are being very honest and straightforward in what we say, the American people are, and our Government is, and we should continue these tests and they will contribute unquestionably to the betterment of the lot of humanity.

The proposal to discontinue them, to me, is very, very high in propaganda value.

Mr. McDONOUGH Thank you

The CHAIRMAN. Mr. Feldman?

Mr. FELDMAN. I just have one question, General.

In considering the importance of the subject, would you say that the alternative is that we will either go to the stars or go to oblivion?

General GAVIN Yes, I would say so.

The CHAIRMAN. By the way, did you bring the charts with you?

General GAVIN. We have them in slides, sir, but the light is so poor in this room that we did not consider them worthwhile. The material has been covered verbally

The CHAIRMAN. We can have them in the record?

General GAVIN. We will provide them for the record.

The CHAIRMAN. Pardon me. I want an open executive session. I instructed the staff to send out a questionnaire to many distinguished persons throughout the country who will not appear before the committee. If the committee has no objections, the committee will support the direction given by the Chair.

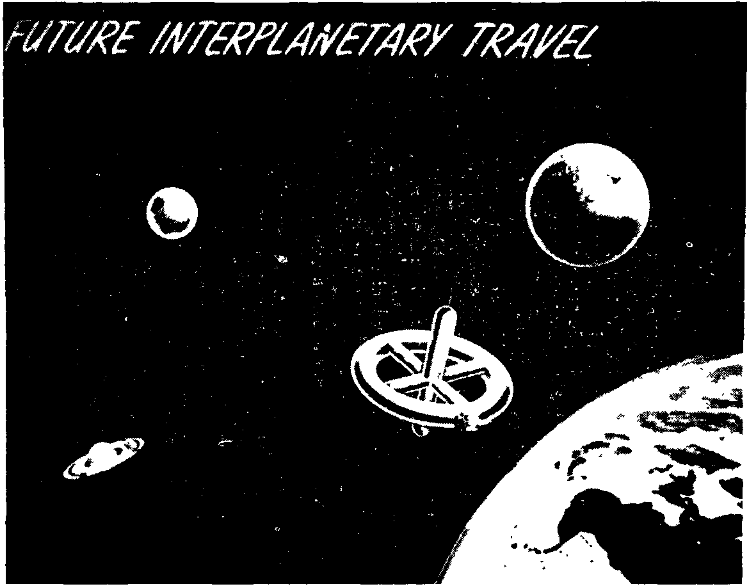
(There were no objections.)

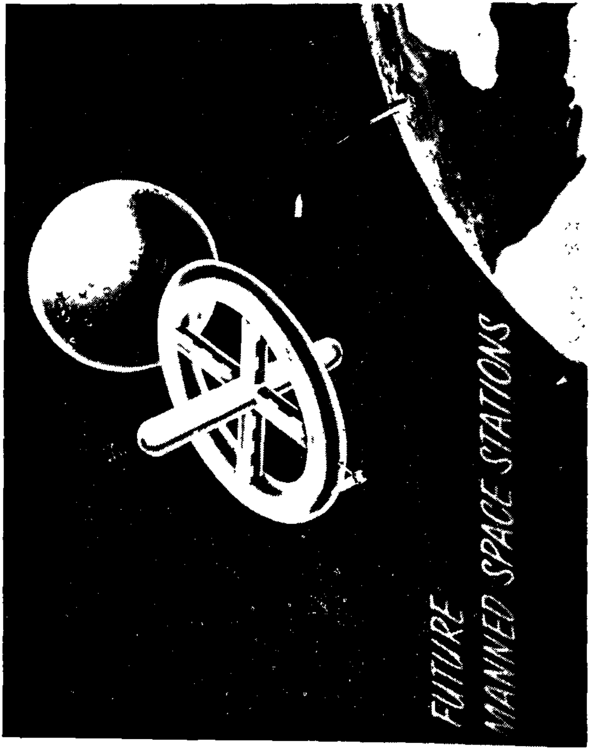
That shows the confidence they have in me.

All right. Mr. Fulton.

Mr. FULTON. We have been talking rather easily about destroying or knocking down missiles and space vehicles that might be up there, but that raises a real problem. This is so because, where these vehicles are, there is no considerable air, but only space. So you cannot have an explosion in the ordinary sense.

(The charts follow:)


FUTURE INTERPLANETARY TRAVEL


FUTURE
MANNED SPACE STATIONS


METEOROLOGY


FUTURE COMMUNICATIONS NETWORK

What is the difference in trying to knock down such a vehicle and trying to knock down a plane? What would be used for explosives or what would the method of approach be? Would we have to run into the missile from the opposite direction it was orbiting or should we have a previous explosion of a sort of shrapnel and have those things go around the world and tear the missile apart as it orbits? Or, because there is no air, is it possible to put anything into space that would, in any way, destroy or block another missile?

General GAVIN. Sir, this has been given a great deal of thought. I think it is rather highly classified. I would strongly recommend that it be taken up in executive session.

Mr. FULTON. Then skip the method.

Is that not a problem?

General GAVIN. It is a very, very serious problem. At first we thought it was rather not too difficult, but we have more respect for it the longer we work with it.

Mr. FULTON. Actually, just reasoning from nonsecret material, you would pretty much have to have the equivalent of a hypergolic fuel as an explosive so that it had the means with it to explode, would you not?

General GAVIN. Yes.

Mr. FULTON. So that any kind of equipment that we might have to knock down another missile would have to have its own oxidation or hypergolic element in it to do its own functioning. This would mean double or triple weight, would it not?

General GAVIN. I would not want to be specific about that, but obviously it would have to get up there, it would have to be responsive to what it is told to do, to have a capability of doing something, moving.

Mr. FULTON. Let me ask you this, too. As a technical matter, on terms, what do you call a whole group of missiles or a squadron? Is it an array or is it a covey or is it a stable? Suppose you saw somebody with a whole group of missiles. What would you say it was?

General GAVIN. Do you mean, actually, just the missiles, not satellites?

Mr. FULTON. Anything. Suppose you saw all these missiles ready to go as we can at Cape Canaveral. What is that, is that a stable of missiles, stand, or brace?

General GAVIN. Ours is organized on the basis of a battalion of missiles or a battery of missiles.

Mr. FULTON. You would call it a battery of missiles, if you were speaking of a number of missiles?

General GAVIN. Yes, because to us a battery would have a certain number of missiles. In addition we would have a rate of fire. Using the standard terminology that the Army uses to refer to weapons and there is nothing particularly complex about it. To us, the missile in the Army has always been an extension of the field artillery art.

Mr. FULTON. Do you feel that the United States should enter into a race with any other country in the field of advancing military art into outer space?

General GAVIN. Sir, I do not think we should enter into a race. We ought to go on our own and let the people race with us.

Mr. FULTON. I am glad to hear you say that.

Finally, my feelings have been, and I was laughed at on the committee last year, that possibly the next major war in the world will take place in outer space and be without casualties, that it will be a system of counters, that we can tell when we are licked when they knock out enough of our satellites. Is that possible?

The next war, instead of being a holocaust, which everybody is predicting, to me may be a war without casualties at all, by merely having military counters which are then destroyed and leave the country open to attack and nobody makes the attack because it is too late.

I was on the cruiser "Boston" off Guantanamo Bay last year and saw a World War II fighter plane fighting two Terrier missiles. Nobody was up there, but they certainly had a pleasant fight one afternoon.

Now, is that not possible in the next war? Instead of thinking we are going to have men involved and casualties, possibly we are going to have a war without casualties, if it should occur, in outer space?

General GAVIN. That seems entirely possible.

Mr. FULTON. Thank you very much.

The CHAIRMAN. Any further questions?

Mr. FORD. General Gavin, I gathered the impression that the military relationship with the AEC has been very satisfactory.

General GAVIN. From my point of view, it certainly has.

Mr. FORD. Would you feel that in this space era a similar set-up of military and civilian would be a good arrangement?

General GAVIN. Yes, sir; including the congressional committees.

Mr. FORD. That is all.

The CHAIRMAN. Thank you very much, General. We appreciate very much your appearance. We know you made a sacrifice to be with us.

I am looking forward to you and your Mrs. and the family being permanent residents of Massachusetts. I am hoping that I will have the pleasure of seeing you frequently up there.

For the entire committee, I extend to you our sincere thanks.

General GAVIN. Thank you, sir.

The CHAIRMAN. Will you also ask Mrs. Gavin to forgive us for taking you away from her and the children.

General GAVIN. Sir; we are looking forward to being among your constituents.

The CHAIRMAN. I am hoping you will be one of my constituents

(Whereupon, at 4:25 p. m., the hearing was adjourned until 10 a. m., Friday, April 18, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

FRIDAY, APRIL 18, 1958

House of Representatives,
Select Committee on Astronautics and Space Exploration,
Washington, D. C.

The committee met, at 10: 05 a. m., pursuant to recess, in the Caucus Room, Old House Office Building, Hon. John W. McCormack, (chairman), presiding.

Present: Representatives McCormack, Brooks, O'Brien, Natcher, Sisk, McDonough, Fulton, and Keating.

Present also: George J. Feldman, director and chief counsel.

The Chairman. The committee will be in order.

We are honored in having as the first witness today the distinguished naval officer and American, Rear Admiral H. G. Rickover. We all know Admiral Rickover; it is unnecessary to refer to his broad experience, knowledge, and so forth.

We are glad to hear from you, Admiral. Do you have a prepared statement?

STATEMENT OF REAR ADM. HYMAN G. RICKOVER,[7] ASSISTANT CHIEF, BUREAU OF SHIPS, FOR NUCLEAR PROPULSION, DEPARTMENT OF THE NAVY

Admiral Rickover. No, sir; I do not have a prepared statement, but I do have one observation I would like to make, if I may.

The Chairman. Admiral, you go right ahead.

Admiral Rickover. I am not a candidate for the first trip to the moon, but I do have a number of suggestions of people I think should go on this trip.

That concludes my observation.

The Chairman. Is there some particular person you would like to see get up there?

Admiral Rickover. Yes, but I should discuss that in executive session. Perhaps your own list is even larger than mine.

Mr. Fulton. This is a one-way trip you have in mind, Admiral?

Admiral Rickover. Yes, sir; a one-way trip.

The Chairman. Admiral, you have read the provisions of the bill, have you?

Admiral Rickover. Yes, sir; I have read the provisions briefly.

The Chairman. And you are acquainted with the purposes of the establishment of this select committee?

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[7] Rickover, Hyman George, naval officer, b 1900; s. Abraham and Rose Rickover; grad. U. S. Naval Acad., 1922; m. Ruth D. Masters, 1 son, Robert Commd. ensign, U. S. N., 1922, advanced through grades to rear admiral; qualified submariner, 1930; assigned to atomic submarine project with A E. C., Oak Ridge, Tenn., 1946–47, continues in development atomic submarine Bur. of Ships since 1947 Recipient Egleston Medal, Columbia Engring, Alumni Assn., 1955. Address care Bureau of Ships, Dept. of Navy, Washington.

Admiral RICKOVER. I am, sir.

The CHAIRMAN. And its duties and responsibilities?

Admiral RICKOVER. Yes, sir.

The CHAIRMAN. In the field in which the committee has to work we all know you have profound knowledge. Would you care to go ahead, Admiral, in your own way, and make a statement in connection with the hearings that are now being conducted, as to the importance of action being taken or the nonimportance, as you see it; what capabilities from a peacetime angle or a military angle the exploration of space—I use that descriptively—might produce; and the necessity for such an action, if any, on the part of our Government; your views as to the type of control, whether it should be civilian or military control—just where the division should be in the world of today? Cover the whole field.

That might just give you an idea.

Admiral RICKOVER. I will try to answer your question, Mr. McCormack. I would prefer if possible that I be asked individual questions rather than to talk in generalities. I could start with whether the organization should be under civilian or under military control. Would that be satisfactory, sir?

The CHAIRMAN. Yes.

Admiral RICKOVER. I definitely believe that the organization should be under civilian control. The Defense Establishment is already too large. If you let it keep on growing, soon it will be controlling the entire country. In fact, rather than putting new agencies in the Defense Establishment, I believe it would be very desirable for Congress to require the Defense Department to justify why it has as many agencies as it does.

One of the great difficulties in running the Defense Establishment is that it is so large. So I definitely would put the new agency under civilian control.

Now that is from an organization standpoint. From a scientific standpoint, I also believe that space is more a civilian than a military matter.

There is today a complete blurring of identity between military and civilian matters. War is now not a matter for the military alone. I am sure you are fully aware that the military is merely the cutting edge of the sword, that all of us, our farms, our factories, our schools, our Government—all of our institutions contribute to the military strength of the country.

For example, there are civilians in this room, and they pay taxes. If we did not have civilians to pay the taxes, we could not have the military. So you see even civilians are necessary to carry on war. And the Congress is necessary in order to pass laws and to furnish us money.

You could look at it this way: By the time intercontinental missiles are perfected it will be possible to hit any one part of the earth from any other part from a land base. Therefore, from the standpoint of being able to wreak destruction, it is not necessary to use space.

You might make an arbitrary distinction between the civilian and the military aspects of space by asserting that as long as a given military effect can be produced by missiles which are fired from the earth, to use space for that purpose would constitute an encroachment on its civilian uses.

With respect to getting into space, it is mostly a case of finding out about it and learning to travel and live in space. From that standpoint it is, in principle, no different than the airplane, which can be used for peaceful purposes or for warlike purposes. So from a philosophical standpoint I definitely believe that space should be under civilian control.

Furthermore, if we are ever to have peace in this tortured world of ours, we must make a beginning—we must get away from the purely military applications of space. We must recognize that the marriage of the military and science is proceeding too fully and too strongly; we must attempt to stop this tendency and instead emphasize the peaceful applications of science.

Have I stated my feelings about this?

The CHAIRMAN. You have stated your views on that subject very clearly.

Do you feel, with civilian control, that in the immediate days ahead there are military implications and these cannot be ignored?

Admiral RICKOVER. The military implications cannot be ignored; but we really do not know today what the military implications of space will be. We are not going to find out until we start investigating and doing research on the problems; only then will these implications become clear. As I mentioned before, sir, there is nothing we do today in the United States that does not have some military implication. When one claims that space has military implications, well, he can likewise claim that our farms have military implications, that our factories have military implications. When we focus on one aspect of a problem we tend to see it out of proportion and we do not realize that nearly everything we do today has military implications. On the basis of its having military implication the Department of Defense could take over everything in the United States, including the Congress.

The CHAIRMAN. The important factor in any agency that is established, whether civilian, or whatever the military does in connection therewith, or independently, is the type of man we put in charge.

Admiral RICKOVER. Yes, sir; the most important element in setting up any agency is the man you put in charge.

There are three aspects to the problem: One is the man you put in charge. The second is where the responsibility for the agency resides in Congress, and the third is where it is placed in the executive branch. But by far the most important aspect is the man in charge because, if he is a good man, it makes little difference what the organization is or where it resides in Congress. The latter two may hinder him to some extent but they will not stop him from doing a job.

But an ineffective man with a perfect organization and even with unlimited sums of money, will not be able to do this job well. The man is the most important factor.

In our country, because we tend to put so much faith in organization and in spending large sums of money to accomplish things, we frequently forget the importance of the individual.

You must always bear in mind that everything in this world is done by human beings or through human beings.

I would not be too concerned with the type of bill you pass, the type of organization you provide, if I were sure that the man placed in charge is a dedicated man who did not surround himself with self-seeking people, or with committees or boards composed of people

who are themselves self-seeking. I am sure you are aware of that. This to me is the important thing.

The CHAIRMAN. Have you an opinion to express as to whether any agency that might come out of these hearings and the Congress should be on a high level as far as power to make decisions is concerned and the authority to carry them out?

Admiral RICKOVER. The administration has recommended that the new agency be made part of the NACA, and I am sure that in making this recommendation the administration has weighed all factors and all considerations and considers this to be the best way of doing the job.

I do believe that the man in charge should be given full responsibility to make decisions, he should not be tied down by boards or advisers.

One of the comments I would like to make about the proposed bill—perhaps there is a later version of the bill than the one I have read—is about the Board of 17 advisers—that these advisers may recommend to the President who the Director of the agency should be, and that the Board shall meet four times a year. It seems to me that you are pretty much tying up the Director by such a board that meets occasionally.

Now the question whether to have a permanent group of people running the job or a group that comes in occasionally was thoroughly thrashed out in the hearings on the Atomic Energy Act in 1946. After extensive discussions with leaders from Government and from industry it was decided that there should be a full-time group, and this is why the Atomic Energy Commission today is composed of full-time Commissioners rather than a board that meets occasionally.

I do not consider it is good to have a large group of people who meet only rarely, and expect them to be effective in advising or running an agency. It would be better if the Director were nominated by the President and confirmed by the Senate. I do not think you should depend on any outside board to make such a recommendation or to be in the position of judging all of the actions of the Director.

The CHAIRMAN. Do you think that any agency should be headed by a commission or headed by a director?

Admiral RICKOVER. The agency should be headed by a director. This is provided for in the current draft of the legislation. I am merely addressing myself as to how he is appointed, how he is advised, and how he operates.

The CHAIRMAN. The reason I ask that question is because you referred to the five full-time Commissioners of the Atomic Energy Commission.

Admiral RICKOVER. Yes, sir. I do not say we should have five full-time commissioners for this new agency. I recommend there be one man, a director. If you do set up a joint congressional committee for this agency, the Director and his staff should report regularly to your committee. My experience in the Atomic Energy Commission has been that the Joint Congressional Committee on Atomic Energy is far more familiar with what goes on in atomic matters than are the advisory groups of the AEC. The congressional committee is not only more familiar with these problems, it is also far more effective. I believe the proposed congressional committee for the new agency could assume this same position.

The CHAIRMAN. Admiral, for the benefit of the members of the committee will you explore the possibilities of the utilization of outer space, first, in connection with peacetime purpose, second, military purposes, having in mind the military aspect of the present situation that confronts the world?

Admiral RICKOVER. A number of military witnesses, Mr. McCormack, who are far more qualified than I am to talk about the military aspects have testified to your committee. But as I see it, what we are doing now is attempting to learn more about the science of space. Our venture into space is a search for the truth, a search to find out about the laws of nature. I do not know what we are going to find, nor where this will lead us. There is absolutely no doubt that we will benefit from this work even though we cannot tell today what these benefits will be.

In any new scientific ventures we cannot tell at the time what is going to come out of them and we should approach them on that basis. We should not decide right now, today, that we are going to build large numbers of spaceships, that we are going to appropriate billions of dollars, that we should set up a huge agency. We should start this program in a modest way. We should give it enough money to do all the necessary research to start off with.

Now, research is not expensive.

Through constant discussion between the Director of the agency and the congressional committee a mutual decision can be reached as to how much to do and how far to go.

If you overburden this agency from the very beginning with a large number of matters, failure may result. I repeat: I would start the agency in a small way and with not too much money. If you start it with a lot of money, you will attract many people into it whose object really is to get in on the ground floor, and these will not necessarily be the proper people, and the work will suffer.

Do not forget, too much money can actually slow the work, because it takes time to spend money.

I see no need for a vast crash program, nor do I believe that the agency should immediately start to set up a large number of its own laboratories. There are many existing facilities in the United States that could be used. The agency should use all existing facilities, both governmental and industrial, to the maximum extent, before it creates new facilities. If we keep on permitting every agency in Government to set up all of its own facilities, pretty soon there will not be enough space left for cemeteries.

The CHAIRMAN. You have pretty strong views, based on your knowledge of the operation of the Atomic Energy Act, as to the part the Joint Committee of Congress plays therein. You have pretty strong views on the joint committee concept, have you not?

Admiral RICKOVER. Yes, sir.

I think the joint committee concept is a fine one and I believe if you were not guided so much by political considerations you would probably establish joint committees in Congress for most things.

The CHAIRMAN. I would not challenge that theoretically, but there are many practical difficulties, Admiral. You are absolutely correct, in my opinion, theoretically. We have joint committees in the Massachusetts Legislature and I am sure other legislative bodies do. But you then have many practical considerations which call for the

committee setup as we do have in the general rule of the committees of the House.

I personally would prefer the joint committee idea because it prevents the duplication of witnesses appearing, and is timesaving. I know all of that. But then there are other difficulties. If you are a member of 2, 3, or 4 committees and have 2, 3, or 4 meetings at the same time, it is pretty hard to be in all of them, and particularly in the Senate, with a body of 96 Members where each may be members of 3 and 4 committees. There are many practical difficulties.

Admiral RICKOVER. You have another practical political difficulty that most Members of the Congress want to be on the Appropriations Committees. You get around that partly by having 2 committees, 1 in the House and 1 in the Senate.

The CHAIRMAN. Of course, money is power.

Admiral RICKOVER. Yes, sir.

The CHAIRMAN. Theoretically, in my opinion, and I cannot speak for anyone else, you are absolutely correct. But there are many practical difficulties in having all committees joint. I am addressing this to a committee of this type.

Admiral RICKOVER. I defer to you as a politician, Mr. McCormack.

Mr. KEATING. We all do.

The CHAIRMAN. Would you say that the duties confronting this select committee and the special committee in the other body are more pressing now than those which confronted the select committee in connection with the Atomic Energy Act of 10 years or more ago? Not that that was not vitally important, but we had pretty much of a monopoly at that time, whereas as may not have today.

Admiral RICKOVER. I do not believe the problem facing your committee is as important as the one which faced Congress in 1945 when the May-Johnson Act was being considered. You were then faced with a problem where it appeared there could be utter and imminent destruction of the world from the uncontrolled use of atomic energy. I do not think the present problem is as urgent as that one was.

The CHAIRMAN. My question was not based on that point of view but from the idea of the necessity of this committee acting with promptness in making its recommendations. In those days we had pretty much a monopoly, based on the practical development that had taken place.

In other words, it is safe to say the Soviet Union is looking into this subject very seriously, too, from their angle.

Admiral RICKOVER. I agree that your committee should act with dispatch to get the agency started, but from the standpoint of the national danger, national urgency, your problem is not of the magnitude that confronted the Congress in 1945 in connection with the Atomic Energy Act, and for this reason:

The urgency for the space agency is said to come not from any civilian applications, but from military considerations.

Suppose a war were to break out today. We probably could not fight even that war with missiles, and yet missiles are much further advanced than any possible military weapons which might be used from space. We would have to depend to a great extent on protecting our country by SAC and by our naval striking forces. These are the only real deterrents we have today. We will have other deterrents in the future, such as Polaris submarines. But if a war broke out today, we

certainly are not in the position to defeat the Russians by the use of missiles. Missiles have not yet reached the operational stage except in the newspapers, and particularly around appropriations time. If this is so, then why do we have to think that space is so particularly urgent right now? The agency should be set up, definitely. It should be done with dispatch. But I do not believe that it is something that should have overriding priority today from a defense standpoint.

You must also be careful in considering this issue to recognize that each of the three services is trying to carve out a niche for itself in future scientific developments. They see the rapidity with which science is advancing, and each of them would like to seize onto something which is attractive and which offers potential so it can be used to bolster its own prerogatives and so help it in the struggle for appropriations.

This is a very natural thing, and typical of any vital organization. The military must not be blamed for this any more than other agencies of the Federal Government that try the same thing. Some of the urgency comes from the desire of each military service to establish beachheads in future scientific developments.

The CHAIRMAN. Mr. Brooks, do you have any questions?

Mr. BROOKS. Yes, I have a few.

Referring to your expression of "marriage of civilian and scientific forces" in sponsoring and developing new inventions in the scientific field, you therefore feel that such efforts should be civilian controlled. I agree with you. I think so, too. But we must all recognize—is it not true?—that the motives which enable us to get the money and to assemble the forces for these developments are largely from the military.

Admiral RICKOVER. Yes, sir; that is true.

But you are saying, "Here we are in Congress, and we are inadequate to decide measures on their own merit, and we also are using the excuse of military necessity to get money."

I agree with you that all you have to do is place a military connotation on anything and then add the words "Russian communism" to it and it has a lot of sex appeal. But if you want to do this job in a proper way—and that is your job as a Member of Congress, and I see you understand that point—why do you not stand up and, as a matter of principle, vote money for science and not necessarily have it tacked onto the military?

Mr. BROOKS. Well, you have a representative government; you have to be practical about it. I am not going to answer your question. I will let you answer it.

But there is no doubt that the money comes from military achievements rather than civilian developments; is that not right?

Admiral RICKOVER. Yes, sir.

Mr. BROOKS. I want to develop this thought in reference to the education of our scientists. You have had experience in dealing with our own scientists. Are you able to measure the grade, caliber, ability, and capability of our scientists in competition with foreign scientists?

Admiral RICKOVER. I think it is pretty well known, sir, that up to and through World War II we in this country were largely dependent on the scientific developments and on the brains of scientists from other countries. The figure which is generally used to estimate the scientific

excellence of a country is its proportion of Nobel Prize winners. We do not come out too well on such a basis.

Since the war there has been considerable improvement in the United States in developing our own brainpower, but unfortunately we have a built-in system of inferior primary and secondary public school education controlled by professional educators who are not scholars which prevents us from doing as well as the European countries in the development of scientific talents. These are the people who take hold of our youngsters in school and teach them that life is all happy, that all you have to do is to learn how to get along with people. They have charge of our youngsters at an immature age, from 6 to 18, and they teach them that they are going to be taken care of anyway, so there is no use striving to do anything hard because the important thing is to get along, to "adjust" themselves. And that pretty much ruins many of them.

This accounts for the fact that we do not have as many good scientists in proportion to population as European countries have.

I am sure you are aware, Mr. Brooks, that our college graduates have about as much knowledge as the secondary school graduates of Europe, and this is the situation which we must rectify.

In fact, I think it is the most important problem facing the country and the Congress.

Mr. Brooks. You are very pessimistic with reference to education, then, of scientists?

Admiral Rickover. Yes, sir, I am very pessimistic. I believe it is the most pressing problem that faces us, and I think if you were not too concerned about political repercussions, instead of having a committee of this kind you would probably organize a committee to investigate what goes on in education in this country and do something about it. I think it is already too late to prevent the Russians from getting ahead of us in education. But if we act rapidly now, if we act effectively, we may be able to redress this impending imbalance 10 to 15 years from now.

Mr. Brooks. Well, you surely would not suggest that the Federal Government take over education and dispossess what you call the professional educators from their jobs, would you?

Admiral Rickover. No, sir, I do not advocate the Federal Government getting into education. A good deal of money is being wasted on education by teaching the children a lot of frills, and by unnecessarily ornate school buildings.

What you could do in Congress is to permit scholars to set up a national standard for education so that parents could find out what their children should learn in school and be able to judge their children and judge the teachers. I would not force anything on the schools, I would make these standards permissible. I would also take control of our educational system away from the "union" of educationists.

Mr. Brooks. When you say "set up standards" what do you mean by that?

Admiral Rickover. As I have mentioned to you previously, sir, for about $50,000—and I know that you do not like to fool around with peanuts like that—for $50,000 you could find out what is being done in education in other industrial countries of the world. You could get an authoritative statement and not depend on the United

States Office of Education, which is controlled by the "union" of educationists.

You could find out what is being done elsewhere and then ask yourselves, "Are other countries doing more for their children than we do for ours?" You could say: "Here is a standard which we recommend to the people." That is about all you could do.

Mr. BROOKS. What would you do with your $50,000 if you go that amount?

Admiral RICKOVER. For the $50,000, I would have scholars analyze what is being taught in all advanced countries of the world, by age groups. I would then say: Here is what the children in Germany, France, or Sweden learn by the time they are 16 or 17; this is what they study; these are the kinds of examinations they must take when they leave high school; this is the ability that they require of their teachers. And instead of applauding when some educationists say we should teach our children to play with dolls——

Mr. BROOKS. So you would not exercise supervision, but you would let our own people know what is being done in other lands?

Admiral RICKOVER. That is right. I would let them know what is being done in other lands. I would exercise no supervision. I would say: "This is what we find is going on in other lands. This is what a 17-year-old knows in Western Europe. It is up to you to put pressure on your own school boards to see that our children are taught at least as much." This is what I would do.

Now, this can be done for $50,000. I hate to mention that sum because I understand Congress devotes about 1 minute for every $2 million appropriated, and I am taking up too much of your time.

Mr. BROOKS. Let me come down a little bit more to the fundamentals of these hearings here.

You feel that the emergency in the development of the space craft is not as great as the emergency in 1946 in the framing of legislation to handle the development of atomic energy?

Admiral RICKOVER. That is correct. I do not consider this emergency as great.

Mr. BROOKS. There has been a lot of testimony before this committee to the effect that the future domination, the future control of the world is tied up in the proper solution of this matter. What do you say about that?

Admiral RICKOVER. This may be true ultimately, but I do not think it is that urgent today.

Mr. BROOKS. You mean, it is not as quickly upon us as——

Admiral RICKOVER. As the possibility of destruction by atomic bombs was at that time. The very people who are telling you of this urgency are the same ones who are responsible for developing IRBMs and ICBMs. Now, then, this amounts to stating that they are going to have effective space weapons before they have missiles ready for war. It is not tantamount to that?

Mr. BROOKS. I rather agree on that, too, but you are not minimizing the importance of pushing forward at once with these developments, are you?

Admiral RICKOVER. No, sir. I firmly believe we should. I agree with the purposes of your special committee, I agree with setting up an agency, and I believe in getting on with the job just as fast

as possible. But I would not be stampeded into saying it is the most urgent thing in the United States.

Mr. BROOKS. Do you not think also that you would give them all the money that they could reasonably use on these projects?

Admiral RICKOVER. Yes, sir, I would do that. But you will find that in scientific ventures you do not need large sums of money to start off with. It is in the hardware stage that you need all the money. If you start in too soon with the hardware stage then you can waste a great deal of money.

Take my own case. When I started out I was only one person, and we gradually built up, added one person, then another. We started off with very small sums of money. I would let this agency prove itself and not set up a vast organization and start in going full blazes on everything. I do not think it is necessary or even desirable.

Mr. BROOKS. Do you feel that the NACA has proven itself already?

Admiral RICKOVER. The NACA has done a good job, sir.

Mr. BROOKS. And we should support it with adequate funds, do you not think, immediately?

Admiral RICKOVER. You are talking of the existing NACA?

Mr. BROOKS. Yes.

Admiral RICKOVER. Oh, yes.

Congress has been very generous not only with NACA but with all branches of the Federal Government. When the history of the past 40 or 50 years is written you will be known as the most generous people who ever inhabited this country.

Mr. BROOKS. This is a rather doubtful accomplishment.

Coming back, the Advance Research Project Agency is a brand new agency.

Admiral RICKOVER. But new research does not necessarily require large sums, sir.

Mr. BROOKS. What I mean is that the Advance Research Project Agency has not proven itself yet. This stipulation in the present bill would eliminate the Advance Research Project Agency, would it not?

Admiral RICKOVER. You mean in the Department of Defense?

Mr. BROOKS. Yes.

Admiral RICKOVER. I stated before, sir, that I believed that the major part of this job should be done by a civilian agency. I also stated that you might go even farther and find out what other things you can take out of the Department of Defense besides this.

Mr. BROOKS. The civilian agency you refer to would be the National Advisory Committee for Aeronautics, is that it?

Admiral RICKOVER. I was merely referring to the general idea of a civilian agency as opposed to a military agency. The administration has recommended it be combined with the NACA, and this is, of course, something for Congress to decide—whether you set it up as a completely separate civilian agency or whether you do it in the way the administration recommends.

Mr. BROOKS. In that agency, whether it be civilian or otherwise, you would certainly have the military represented?

Admiral RICKOVER. Yes, sir. No matter what the agency is, whether it is included within NACA, or whether you set up as a separate civilian agency, I would have the military represented somewhat in the way it is represented in the Atomic Energy Commission.

As you know, they have a Military Liaison Committee which meets with them regularly and sees to it that the interests of the military are taken care of.

When the Atomic Energy Act was being considered by Congress in 1946 there was much fear that a civilian agency would not adequately take care of military interests and requirements. That was the reason for the establishment of the Military Liaison Committee.

The fears of the military have turned out to be groundless. The Atomic Energy Commission has amply taken care of military requirements, and officials from the Department of Defense, both military and civilian, have frequently said so. In fact, the military have probably gotten more money for the development and manufacture of atomic weapons because of the existence of the civilian Atomic Energy Commission than they would have otherwise been able to—because the Atomic Energy Commission is a separate agency and uses its own efforts to augment the efforts of the Department of Defense.

In the case of weapons research and development I am certain we would not be so far advanced if we had left it entirely up to the military. The fact that the Atomic Energy Commission is a civilian organization makes it easier to obtain good scientists and engineers in its laboratories.

In the case of nuclear propulsion for naval vessels we definitely would not be anywhere as far advanced as we are today if it had been handled primarly in the Navy. We would not have gotten the necessary funds and the required degree of support. The Navy still supplies only a small portion of the money for research and development in this field.

So I say that anyone who fears that a civilian space agency will be detrimental to the military should find out how the Atomic Energy Commission has worked out. If I were responsible for space matters in the military and if I had no intent but to get the job done fast I would grab at the chance to have it assigned to a civilian agency.

Further, you must remember that once the Atomic Energy Commission finishes its research and development on a project it is turned over to the user—whether he is a civilian user or a military user. So I cannot see why there could be any objection by the military to a civilian space agency. In fact if they are smart they would be urging this on your committee.

Mr. Brooks. I helped write that legislation years ago.

Admiral Rickover. That was a very fine way to do it.

Mr. Brooks. But in this instance, would you have the Navy, for instance, represented?

Admiral Rickover. I would not have the services individually represented. I think you would be going contrary to the whole trend in the Defense Establishment. I would have the Department of Defense represented and let the Secretary of Defense decide for himself how he wants to do the job. I would not tie him down.

Mr. Brooks. You would support it with a military committee in liaison?

Admiral Rickover. Yes, sir. And not tie it down so it definitely has to be members from each service.

Mr. Brooks. I think it is vitally important that the military know what is going on there, so that they take advantage of developments.

Admiral RICKOVER. I agree with you. I want to be sure you understand me sir. I stated that I was for having the military actively represented, but I would not tie the Secretary of Defense down and force him to appoint a member from the Army, the Navy, the Air Force, and the Marines. Let him decide on how he gets his representation. This is the point I was making.

Mr. BROOKS. You mean, give him more latitude?

Admiral RICKOVER. Give him the latitude to decide on the representation he wants because, after all, you are holding him responsible, and if you hold him responsible you ought to let him do the job in his own way.

Mr. BROOKS. That is all, Mr. Chairman.

The CHAIRMAN. Mr. O'Brien.

Mr. O'BRIEN. Admiral, you touched briefly on your own experience and said you started with a small appropriation?

Admiral RICKOVER. Yes, sir.

Mr. O'BRIEN. I think we all know what a magnificent job you have done from such a small beginning, moneywise. I would like to ask this question, and I hope you will not think it is too abrupt or too pointed. But I have been disturbed by suggestions in testimony that people are given a job to do, they do a good job, and then suddenly there is a change. There is not the continuity that there should be, which leads up to this question:

Are you assured of being retained in the Navy during the next few years to finish building a nuclear Navy?

Admiral RICKOVER. Do you want an answer that is equally as abrupt as your abrupt question?

Mr. O'BRIEN. I would be delighted; yes, sir.

Admiral RICKOVER. The answer is "No, I am not assured."

Mr. O'BRIEN. You have no assurance whatsoever?

Admiral RICKOVER. No, sir.

Mr. O'BRIEN. I would like to ask you this question, and I think it ties in with what you have said so far:

It is not true that one of our weaknesses in this country has been too much reliance upon what we call mass production? We get a certain conventional weapon, we will say, and we can outproduce any nation. But we are now entering a field where mass production is not the answer. Is that correct, Admiral?

Admiral RICKOVER. That is correct.

There is a great degree of obsolescence of equipment, a greater degree than there ever has been, and, of course, that degree of obsolescence is increasing all the time. This, of course, is where the money is spent. Large sums of money are not spent in research and development; the big money is spent in production.

On the other hand you have industry that gets geared up to do a job, and they like to turn out tanks and planes just as fast as cigarettes. It is pretty difficult, once you start on assembly line operating, to shut it off. And this is the great danger—forces build up to keep the production lines rolling, even when the equipment being turned out may be obsolescent.

You are stating the matter in a somewhat different way than I did, but we are thinking about the same thing. I would spend all the money that is necessary on research and development because, as we

well know, the amount of money we spend that way is relatively insignificant. But I would stop compounded duplication between the services in the manufacture of production items. This is where a considerable amount of money gets spent.

Of course, the larger the Defense Establishment becomes, the more connections it has with industrial and scientific and educational organizations, and the more pressures are exerted on it. It is an ever-growing spiral. This is what I meant by the Defense Establishment being too large.

If Congress really wants to save money, it is going to have to cut down the size of the Defense Establishment, it is going to have to see to it that everything that can possibly be done by the civilian economy is done by that economy and not by the Defense Establishment.

Another aspect of this is to the one of management. The people who run the military are the operators. I will confine myself to the Navy because I know more about it than I do about the other services. Officers who are used to command at sea come to Washington for short periods of time. They are given positions where they control technical decisions. Now, I maintain that only people who have some technical qualifications should be in positions where they make technical decisions. A great deal of money is wasted when wrong decisions are made by people in military authority, whose subordinates have been trained or have learned to obey military authority, and so will not always say what they really think. Scientific and technical matters cannot be solved by military orders. Nature knows no rank.

I am sure that we could get our prototype atomic energy ships, the nuclear ships, built faster if they were not in the military. If I had been able to build the *Nautilus* entirely in the AEC, I could have done that job faster.

Actually, what I wanted for the *Nautilus* was eventually done anyway, as it has been for the other nuclear ship prototypes. But much of my time has been spent fighting off people who come in just like on a transmission line every 2 or 3 years and who have to be educated. Then when the are educated, off they go and some other officer comes up on the transmission line.

Is that a good speech?

Mr. O'BRIEN. That was very good.

Admiral, we have heard the phrase "leapfrog."

Admiral RICKOVER. Yes.

Mr. O'BRIEN. It has been used a lot.

Admiral RICKOVER. Yes.

Mr. O'BRIEN. Is it not a fact that is what the Russians did to us? We were just assuming they were catching up in the nuclear field and they had the research scientists actually working ahead, and they suddenly unveiled these accomplishments?

Admiral RICKOVER. May I answer that in a broader way, sir? The Russians, as you well know, have a plan for world domination, and they have been working on that plan for the past 30 years. There are changes in government, there are changes in methods, but they resolutely go ahead toward that same goal.

We have no such national plan. We have prided ourselves on being democratic. Some take that term to mean that anyone can do anything he wishes. Now there are limits even to democracy, because if

you let everyone do anything he wishes, he will ultimately destroy himself and the Nation as well.

I do not mean by that that we should have military control. You can tell from the tenor of my remarks that I do not believe that. But the Russians have done two things which, in my opinion, are outstanding.

One, they have recognized that in this modern scientific age they must train people technically and scientifically, and they have done an outstanding job. As an example, they are graduating more astronomers from one university in Russia than we graduate throughout the entire United States. They are graduating 5 to 6 times as many metallurgists as we are. Metallurgists and astronomers are the very people we need for the space program, but we do not have enough of them. This, the Russians have accomplished by offering additional incentives to study astronomy and metallurgy.

We have deluded ourselves into believing that a man must live in a democratic atmosphere, in an atmosphere of freedom, to be a good scientist or a good engineer. But this is not necessarily so. We see evidence of the work of the Russian scientists and engineers, yet we still refuse to believe that they are capable. The reason, I suppose, is that it takes human beings too long, much too long, there is too much inertia in our thinking, to change fast enough.

To give you a minor example which illustrates that freedom is not necessary for scientific work, there is the famous case of the biologist in Nazi Germany. He was asked why did he not get out of Germany while there still was time, and he said, "The Nazi Party gives me all the guppies I need to experiment with." And the ability to obtain these guppies—these are the little fish you buy in the 10-cent store—was more important to him than to leave Germany and live in freedom.

The other thing the Russians have done besides vastly improving their education—is to reduce their lead time. They have learned how to cut lead time on important military items to roughly one-half of ours.

By lead time I mean the time from inception of an idea until the finished item is rolling off the assembly line, ready for use. And they have done it in a very simple way.

They have put a man in charge of a project and said, "Joe, you do this or else." And they do not bother him while he is doing the job, provided he produces.

But what do we do: First, we never put anyone in charge. I defy you to find anyone in the Federal Government that has any final responsibility for anything, a clear-cut responsibility. I know that Members of Congress have tried for many years to find such an individual, but you cannot locate him. Certainly not in Washington.

How can you possibly have real responsibility, particularly in the military where the people keep on changing all the time? So if something goes wrong, the man occupying the desk at the time can say, "Well, the man that was here before me started it—he is responsible." And the man who started it can say "I left the job before it was finished, so I'm not responsible." This freedom from responsibility is a marvelous invention.

So we in the military have a "union," too. This is our union—that we are not around long enough to be responsible for anything. You

must have responsibility if you are going to get a job done. And once you give a man responsibility you have got to see to it he is not bothered too much by the pure administrators who are always making sure that the many minor rules and regulations are carried out exactly. Just like the requirement every month to collect for personal local telephone calls. You could say, "Well, I will get busy and write a letter to somebody to stop this foolishness," but it takes too much time, so you pay 10 cents every month. It is that sort of thing.

Mr. O'Brien. Thank you very much.

Admiral Rickover. Have I answered it?

Mr. O'Brien. You certainly have. I appreciate it.

The Chairman. Admiral, you have under your direction two major laboratories now?

Admiral Rickover. Yes, sir. I have the Bettis Laboratory of the Atomic Energy Commission in Pittsburgh which the Westinghouse Co. operates for the Atomic Energy Commission, and the Knolls Atomic Power Laboratory at Schenectady, N. Y., which also belongs to the Commission and is operated for them, by General Electric Co. There is also the Windsor, Conn., Laboratory of Combustion Engineering, Inc., which is working on a submarine plant for us.

The Chairman. What do you do for the Navy?

Admiral Rickover. What do I do for the Navy?

The Chairman. Yes.

Admiral Rickover. Well, I draw my pay from the Navy.

The Chairman. I was not asking from that angle, Admiral. I wanted to get a picture for the record.

Admiral Rickover. I have dual duties, sir. My primary duty is my assignment by the Secretary of the Navy to the Atomic Energy Commission. In that capacity I am responsible to the Commission for the design and development of nuclear reactors for the propulsion of naval vessels.

In the Navy Department I am Assistant Chief of the Bureau of Ships for Nuclear Propulsion. My job is the design and installation of nuclear propulsion plants in naval vessels.

For the first one of a new type nuclear propulsion plant, I am responsible for the complete propulsion plant from the reactor right through to the propeller. For follow ships, that is, for the second and subsequent ships, I am responsible for the reactor plant.

I am also responsible for the design, development, installation, and procurement of all the materials that go into these plants and for setting up and training the industrial organizations that make them, for training the shipyards in nuclear ship applications, for training the crews of our nuclear naval vessels, for seeing to it that what Congress wants us to do is done, for using competitive bidding, and so on. Does that answer it?

The Chairman. Well, yes. I wanted to get into the record what broad jurisdiction and responsibility you have. You have both peaceful and military objectives?

Admiral Rickover. Yes, sir. I am also responsible for the Shippingport atomic power plant. This is the first large-scale central station atomic power plant built in this country. It delivers 60,000 kw. of electrical power. It is generating electrical power for the city of Pittsburgh right now.

The CHAIRMAN. That is for peacetime services, as I remember.

Admiral RICKOVER. Yes, sir; however a reactor does not know the differences—whether it is supplying electricity for a naval vessel or for civilian use. There is not much difference; the same design principles apply to both. What is used in one is adaptable to the other.

The CHAIRMAN. How many assistants and help—I put the word "help" not in the sense ordinarily used—are under your jurisdiction?

Admiral RICKOVER. I have about 100 scientific and technical people at headquarters. You do not need many people, because if you build up to much of a staff then your time is taken up with them—stenographers start in crying and all that. You do not want a lot of people around, you want just a few people: you use as many outside organizations and people as you can.

The CHAIRMAN. When you use outside organizations and they make any discoveries or advances does the Government get the benefit?

Admiral RICKOVER. In accordance with the Atomic Energy Act, any inventions or discoveries that are made ipso facto belong to the Government because it is all being done with Government money—I believe the revision of the Atomic Energy Act in 1954 tends to modify that to some extent.

I strongly urge that in this bill you make it mandatory that anything that is discovered belongs to the United States Government, and for this reason: If you do not do so, you will start a fight between the advocates of public control and private control.

I would hate to see developed a private versus public fight for ownership of the air. I would definitely prevent that. I would provide in this act, since all of the research and development is to be done with Government money and to discourage industrial organizations from trying to encroach on it, that the air belongs to the people of the country, because it is the people's taxes that will pay for the development of space.

If you state this clearly in the law, you may stop some of the difficulties that have arisen in the atomic energy game. If you recognize this now, if you have somebody on your staff get into this problem and make it very specific that these developments belong to the people of the country and not to anyone else, that should prevent some difficulties.

The CHAIRMAN. Admiral, you will have the opportunity, as other witnesses, to edit your testimony.

Admiral RICKOVER. Not after the newspapers get hold of it.

The CHAIRMAN. I know if we did not have the newspapers we would be in very bad shape. I know you will agree with me on that.

Admiral RICKOVER. Yes, I do.

The CHAIRMAN. We all have our bones to pick with them occasionally.

Admiral RICKOVER. Yes, sir. It is very fortunate that we have them to watch what we in the executive branch do and what the committees in Congress are doing.

The CHAIRMAN. In your editing you can elaborate on any of your testimony, and particularly in connection with, but not confining it to, your last observation about the possible improvements that we could make in this over the Atomic Energy Act in the light of their experience, and they were pioneering.

Admiral RICKOVER. Yes, sir.

The CHAIRMAN. I would like to have you elaborate on that as to what suggestions you think could be made.

Admiral RICKOVER. Yes, sir.

The CHAIRMAN. As to the work done in the committee, and we all will read these hearings many times.

(The elaboration above suggested is as follows:)

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C., May 7, 1958.

Hon. JOHN W. McCORMACK,
Chairman, Select Committee on Astronautics and Space Exploration, House of Representatives.

DEAR MR. McCORMACK: At the time of my testimony on April 18, 1958, before your committee you asked that I submit comments for the record on patent provisions for outer space legislation.

Of course I lack the expertness to recommend specific legislative language, but I would like to make some general observations. I believe that one can distinguish clearly between patent rights arising from discoveries made with the expenditure of public money and those which are developed privately. In the case of inventions conceived during the course of a Government contract or similar relationship, strong provision should be made for the patent rights to be vested in the Government. A provision such as this does not freeze patents because the Government has continuously licensed others to use such patents in the interest of the country as a whole

Whenever a private party conceives of an invention or discovery and no Federal funds are involved in the work, he has a rather sacred constitutional right to the exclusive use of his invention or discovery. I do not think that writing a provision in outer space legislation which would award the Government title to patents developed with the use of Government funds would, in any way, infringe upon this right.

Perhaps some may think that this oversimplifies the matter but I have long felt that the patent provisions of the many laws surrounding Government research work could be simplified to a greater extent.

I do feel strongly that no provision of the law setting up the space agency should ever be construed to confer on any individual a right which could in any way impede or restrict the use of relevant technology by our Government for domestic or for international purposes. An unequivocal statement to this effect in the law would be an earnest of our intention to help other nations.

I hope these comments are of help to you.

Sincerely yours,

H. G. RICKOVER,
Rear Admiral, United States Navy.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Admiral, one of the main duties of this committee is to make the necessary recommendations providing for research into problems outside of the earth's atmosphere.

Going back to this question of urgency, I understand you are of the opinion that a crash program is not necessary at the present time, and that this program is not urgent enough to demand appropriations of large sums of money. Am I correct in that?

Admiral RICKOVER. Yes, sir.

Mr. NATCHER. You mentioned the sum of $50,000 as a starting amount.

Admiral RICKOVER. No, sir; no. I was talking about another subject.

Mr. NATCHER. Education?

Admiral RICKOVER. Mr. Brooks and I had previously discussed the establishment of standards for public-school education. The $50,000 was for that purpose.

Mr. NATCHER. That pertains only to education?

Admiral RICKOVER. That pertains only to education.

Mr. NATCHER. Admiral, what suggestions would you have as far as appropriations are concerned in this particular field as to amounts? Should the amount be large or small?

Admiral RICKOVER. I cannot answer that question specifically, sir. I do know this: that research does not take a large sum of money. It is the production of hardware that does.

The CHAIRMAN. You are talking about basic research?

Admiral RICKOVER. Yes, sir. Even a lot of applied research does not cost too much.

The point was made before about not rushing into the manufacture of large quantities of hardware items, because today everything becomes obsolescent so quickly. Research is not going to cost too much money.

The principle I was trying to establish was: Don't start off with a big full-blown organization, staffed with all sorts of people, with a big public-relations staff, and all that. Start it off in a small way and let it build up. Let the agency have faith and confidence in the committee you are going to appoint, that they can come to the committee with their problems and that they will get quick action. Make it flexible. Do not just say, "Here is a lot of money to spend."

Has it not been your experience that whenever you appropriate large sums of money it is always spent?

Mr. NATCHER. Admiral, I am a member of the Committee on Appropriations, and the statement that you made concerning appropriating large sums of money, and apparently small sums, certainly does not apply to two of my good friends, my Chairman, Mr. Cannon, and Mr. Taber. They are two of the members of the committee that believe in holding appropriations down, and we also have other members on that committee that do, also, Admiral.

Admiral RICKOVER. Yes, sir; but you also have a lot of experts coming to you and telling you that unless you appropriate the last penny they ask for the country is going to fall. Then you do not know what to do.

Mr. NATCHER. Admiral, you are not one of those persons that believes that Russia should place in orbit 48 satellites that will every hour and 15 minutes drop a note on the steps of every capitol of every State in the United States informing the people there as to weather conditions, and then say, "Well, we are a little behind"?

Admiral RICKOVER. No, sir.

Mr. NATCHER. You believe as far as our satellite program and our general missile program is concerned that we should have ample appropriations at the present time, do you not?

Admiral RICKOVER. Let me put it this way, sir:

From a defense standpoint I believe that we will have effective missiles which we could use for returning an attack by the Russians before we will have effective means of retaliation or attacking the Russians by means of space weapons.

Does that state my opinion of it?

Mr. NATCHER. Yes, sir.

One of our greatest achievements of modern day government, you will agree, was placing in action our nuclear submarine, and you are to be commended on the fine part you played in that program. Now, comparing that particular project with the project we have under

consideration here, Admiral, how does it compare from the standpoint of the starting days? Did you have the necessary interchange of knowledge as far as our allies were concerned?

Admiral RICKOVER. There was no knowledge available to be exchanged at that time in that particular field. But what I did have was this, which is more important than getting access to knowledge: I surrounded myself with 7 or 8 people who were smarter than I was. This is the sole criteria I use at all times for hiring people. I will not hire anybody that is not smarter than I am.

Then we had access to all the knowledge that was available in the Atomic Energy Commission and elsewhere in the United States. People did not come to us bearing this knowledge on silver platters; we had to go out and find it for ourselves. This is getting to be a rather uncommon thing now.

Apparently the way to lick all problems today is to go to Congress, get large appropriations, and depend on trained scientists waiting to be hired to come and work for you. Life is just not like that. It is not that way in science, it is not that way in the military, and it is not even that way in politics.

I know what Congressmen have to do to get elected: You have to struggle and you have to scratch. When a man wants to do a job in science he also has to scratch.

Mr. NATCHER. Admiral, from time to time we hear statements to the effect in this country we are not pooling our scientific knowledge with our allies, we are not deriving the benefits that we should receive as a result of this pooling of knowledge.

Admiral RICKOVER. That is correct.

Mr. NATCHER. You feel we are deficient as far as that phase of the program is concerned?

Admiral RICKOVER. I definitely do. To have a true entente, a true working together with the Western European countries we should exchange all manner of information with them. It is very foolish of us not to do that.

Mr. NATCHER. Admiral, in your opinion does science deserve a place in the Cabinet at the present time?

Admiral RICKOVER. Well, that is a hard one. Does science deserve a place?

I do not know that I can answer that question. The question arises because scientists are more vocal and articulate than a lot of other people—you hear more from them. But I would rather trust my destiny to a committee of Congress than I would to a committee of scientists.

Does that answer your question?

Mr. NATCHER. That answers it, Admiral, and I want you to know that I am inclined to agree with you.

Thank you, Mr. Chairman.

Mr. FULTON. We all agree.

Admiral RICKOVER. I am sure you agree because I am saying a nice thing about you.

The CHAIRMAN. But we have to rely on testimony from gentlemen like you and others in your field and in the scientific field, which sort of lets us apply what little commonsense we have.

Admiral RICKOVER. Well, you have to recognize what the scientist really is. He is a man who is interested in learning new things, in

developing a new formula. But unfortunately he is generally so engrossed in that formula, that when he evolves it he thinks the whole problem is licked, and he wants to go on to evolve another formula. But what he has actally done with his formula is to donate a legacy of terrifically hard, painful problems to the engineers which will take up their time for many years. I have to take that scientific formula or concept and try to translate it into a workable and reliable piece of hardware.

When a scientist makes a mistake, he takes an eraser and erases it; but when an engineer makes a mistake, he has to wear it around his neck where everyone can see it. That is the difference.

The CHAIRMAN. I am not going to get into that broad discussion now.

Admiral RICKOVER. By this time you should have many scientific qualities, having heard so many scientists.

The CHAIRMAN. You are unnecessarily generous.

Mr. Sisk.

Mr. SISK. Admiral Rickover, I would like to read one sentence here and ask if you agree with it.

> One of the most frustrating problems concerning American current activities in space projects is what arises in connection with the difficulty of pinning down responsibility for progress or lack of progress.

Do you agree with that?

Admiral RICKOVER. I definitely do, but that applies to any field, not only to the space field. It applies to the grocery field, too.

Mr. SISK. Do you feel that the bill which we have before us, in any event, will solve that situation with reference to space?

Admiral RICKOVER. I am trying to be impartial.

Mr. SISK. I refer to the matter of pinning down responsibility. We are talking here about space now.

Admiral RICKOVER. No, sir, it does not touch on that at all.

Mr. SISK. The bill which we have before us does not touch on that?

Admiral RICKOVER. Any more than any other bill that you have passed assigning functions to agencies of Government. This bill is no different from the others; I do not see where Congress has been very effective in getting responsibility to be assumed in other fields. Why do you then think that in space, which we know so little about, you will all of a sudden get people to accept responsibility?

Mr. SISK. All right. Let me ask you this:

Do you have a suggestion or recommendation to make to this committee? We were given a responsibility to come up with something in order to pin down responsibility. What is your recommendation?

Admiral RICKOVER. I have tried to hint at solutions.

I would say this: One of the reasons I recommended against military control, is because the military man is changed too often. I said you could not get adequate responsibility where the man did not stay around long enough—where there was a constant change of personnel. I do not know whether you were here when I made that statement.

For the civilian space agency you have the same problem.

This is what I would do if I were on the Appropriations Committee: If a man came up and asked for an appropriation for a certain project, I would say, "Whose idea is it? How far is it along? Who is going to be responsible? Is he going to stay on his job for the

duration of the project? When will it be finished? Will it really be operational or will it still require several years of testing? Will you report to us each year how close you are to meeting your original schedule, and why you are behind? How much will it cost? Will you personally take responsibility? And what do we do to you if you don't succeed?"

Try that and you may get a reduction in requests for appropriations.

The CHAIRMAN. Admiral, on the question of men not being around long enough, that could be taken care of in the Defense Department, could it not?

Admiral RICKOVER. Oh, yes.

The CHAIRMAN. We have known this for years. That is not anything new. I was on a subcommittee that looked into that in 1945, the Riehlman subcommittee.

Admiral RICKOVER. On research and development. I remember that.

The CHAIRMAN. As a matter of fact, I had a very important part in bringing that subcommittee about.

Admiral RICKOVER. You had an important part in getting the report printed, yes, but I think that is where it stopped.

The CHAIRMAN. I sat in on all the hearings.

Admiral RICKOVER. I have read the record.

The CHAIRMAN. Those are human qualities. In no matter what walk of life you are bound to meet them. But the question is to try and reconcile them, and I remember we recommended very strongly the establishment of a corps within the departments where young men or officers could devote their whole life to the field of research and technology, and again with the opportunity of advancement. That is a human trait.

If I were in the Army today or the Marine Corps or the Air Force, I would like to go ahead if I were making it a career. That is human. I could see where men would want to get into some branch where the opportunity for advancement was more rapid. Again, it is a human trait.

So that could be taken care of within the Defense Department, could it not?

Admiral RICKOVER. Yes, sir, it could.

The CHAIRMAN. We cannot do everything by legislation. We could, but we should not drive it down their throats.

Admiral RICKOVER. You cannot drive it down their throats. But if the chairman of the Appropriations Committee says something to a Government agency, they listen. You are listened to more than you realize.

The CHAIRMAN. Suppose the chairman of any committee, without appropriations, might be wrong.

Admiral RICKOVER. Why should you be any more wrong than a bureaucrat?

The CHAIRMAN. I cannot answer that question. I have accepted that we are all human beings and it is human to err.

Admiral RICKOVER. You tell me you sat through many days of hearings, and I happen to have read every word of the Riehlman committee report. The committee put a great deal of effort into it

and it was a fine piece of work. You finished that job and then were not interested enough to put those recommendations into effect. That is where I indict you.

The CHAIRMAN. Of course, the putting into effect was 95 percent administrative. Under the law they had the power to do it within the Defense Department.

Admiral RICKOVER. But the Defense Establishment does not want to do a thing of that sort because they are still going along with some outmoded theories on how to prepare for modern warfare.

The CHAIRMAN. Without going into all that—because I see you and I basically agree—the power and the authority rest within the Defense Department to meet that particular situation.

Admiral RICKOVER. Yes, it does, and this is one of the reasons why the Secretary of Defense wants to get some more authority. I believe he wants to put some of these things into effect.

The CHAIRMAN. I have some views on that, but I do not want to get too far into that now because that is going to be one of the battles of the generation, I would imagine, from what I see in the newspapers.

Mr. Sisk.

Mr. SISK. Admiral, would you make some specific recommendations to improve this bill in order to pinpoint the responsibilities which you think so necessary, and which I agree with you are necessary?

Admiral RICKOVER. I mentioned previously the 17-man board of directors that meets 4 times a year. Of course, any suggestion that I make would require a great deal of study on your part. You might inquire about the efficacy of various boards of this kind in Government agencies, how effective they really are, whether they are merely figureheads, and whether logrolling occurs with these groups, and so on.

Mr. SISK. Let me ask you this, Admiral.

As I understand, one of your criticisms is the fact that people change and no one knows today whether he is going to be here tomorrow and cannot carry out the job in many instances.

Admiral RICKOVER. Yes, sir.

Mr. SISK. Let me ask you this:

If we provided in this bill a director and granted him the power and authority to assume the responsibility and set his term at 20 years or 30 years by law, where he could not be removed except for the normal things that would cause impeachment, such as the actual violation of law—something of that kind—would that in any sense tend to help?

Admiral RICKOVER. I do not agree with so long a term for a job of this kind. The normal tour in a commission is about 5 years. I think that is adequate. The man appointed to head an agency should come up for confirmation by Congress periodically, otherwise you can get a man in for 15 years who is doing a poor job, and you have no way of getting rid of him.

Put the man in for a 5-year term, and especially where you have a special congressional committee you can amply judge whether he is doing a good job.

This new agency is a good example where the Senate should really exercise its constitutional duties of advising and consenting. The

Senate does not do this effectively in many cases because it just does not have the time to. I am sure you are familiar with that.

But in the case of important appointments, and where there are interested congressional committees, the committee might, by a special rule set up by Congress, have the opportunity to advise the Senate whether the man is doing a good job or not.

Mr. SISK. I appreciate the statement, and I agree with that. I personally would not favor 20 years. I was just trying to find some way of overcoming your particular objection to the fact, as I understood a while ago in your discussion with some of the other gentlemen here, that we had changes too often.

Admiral RICKOVER. May I discuss this a little more?

Mr. SISK. Yes.

Admiral RICKOVER. If you could keep this field out of politics and away from other pressures, you will do good. But the tendency, as I have seen it, is that pretty soon you start getting pressures of one kind or another; they may even be political, they may be from universities, they are not always industrial.

The CHAIRMAN. They might be friendships.

Admiral RICKOVER. Yes. As a matter of fact, friendship has been known to influence politics also, Mr. McCormack.

The CHAIRMAN. True. But I simply am trying to elaborate a little. It is not necessarily confined to the field of politics. Friendship could influence——

Admiral RICKOVER. Friendship does influence it, sir. But I have found out, if a man tries to do a job and does not worry too much about himself, he does not have to worry about his friendships.

For instance, I consider that all of the members of Congress are my friends. I do not know too many of them personally, but I am sure that you are all my friends. I do not think there has ever been a single occasion where I have ever been asked to, or have ever done anything out of line for any Member of Congress, and yet you are still my friends.

The CHAIRMAN. I would not want you to say that you never did a thing for a friend, whether in Congress or out of Congress. You would not want the record to show that.

Admiral RICKOVER. Not where Government money is concerned.

The CHAIRMAN. Well, that is a different proposition. All things being equal, you would give a friend a break, would you not?

Admiral RICKOVER. Oh, yes. For instance, if I lived in your district, I would probably vote for you.

Mr. KEATING. That is the friendliest thing you could do.

Admiral RICKOVER. I would like to get back, if I may, Mr. Sisk, to discussion of the question you asked me.

I assume that Congress will probably set up a committee. I gather from the tenor of the questions and what I have read in the papers that that is so.

You should try to keep people off that committee who might be interested in it solely because of its glamour or because Members will be able to make profound statements which the press prints, and so on.

You should really try to get Members who are sincerely interested in this program, and regardless of their seniority.

At the closed hearings we had with Mr. McCormack recently, I suggested to him that he already had a pretty good job in Congress and he need not try to become chairman of this committee; he agreed with me and stated he did not want to be the chairman.

Mr. FULTON. A lot of us think he ought to be.

Admiral RICKOVER. He ought to be, but he cannot put in enough time on it. Certainly he ought to be, but he knows what I meant by that. I simply say with all of his other honors he does not have enough time to take over a committee.

The CHAIRMAN. Thanks, Admiral, for recognizing my problems.

Admiral RICKOVER. I do. And furthermore, you have done enough for your district already.

The CHAIRMAN. Can you convert some of my enemies?

Admiral RICKOVER. In 1946 the first Chairman of the Atomic Energy Commission was Brien McMahon, a first-term Member of the Senate, who had not even been in the House. It was very fortunate for this country that a man as dedicated as Mr. McMahon, and as intelligent, and who worked as hard, got the job. He never permitted any politics to enter into it. I hope in the assignment of members to this committee you will disregard all questions of seniority and political party.

The committee must become a body that people recognize has a very important national function in addition to its congressional function. It is because the members of the Joint Congressional Committee on Atomic Energy have been so dedicated that they frequently have been listened to by all of the Congress even at times when the cause they were espousing was not popular. Congress has listened to them because they felt they were doing it for the good of the country and for no other purpose.

Mr. SISK. Admiral Rickover, in view of your concern regarding the aspects of education and so on, let me ask you this:

Do you feel that at the present time we are fully utilizing our engineering and scientific capacities and manpower that are actually available to us in the United States?

Admiral RICKOVER. No, sir, we are not fully utilizing these capacities and people.

One obvious way we are not utilizing these people is because a considerable number of them go into business, where they get paid more than they do in science as in engineering. You cannot very well blame a man who has a family because he does not work in a profession where he cannot support his family.

That is true of our teachers, too. I place a higher priority on teachers, on improving their abilities and increasing their salaries than on scientists and engineers because we are not going to have good scientists and engineers unless we first have good teachers.

Again I would like to get back to the basic issue, if you will pardon me, and that issue is the quality of our teachers.

Mr. SISK. All right, then; that calls for additional pay and additional money.

I felt just a bit of criticism on your part, probably, of the fact we cannot talk in small sums around here. We, then, in Congress must see to this—will you agree?—that better salaries are provided not only for scientists and engineers who are now devoting their ef-

forts to the particular problems we are concerned with, but to the teachers at university level, and so on? Is that correct?

Admiral RICKOVER. Yes, sir; that is correct. I would like to discuss this matter in two parts.

First, the question of scientists and engineers, and second, that of teachers.

As far as the Government is concerned, I believe Congress has been generous in the pay scales for scientists and engineers. They get paid pretty well.

The Federal Government does a good job in paying professional people. I think if we were a little more strict and checked up on some of the high-paid civil service people, we would find some of them are not too well qualified. I would not worry too much about the pay of civil service scientists and engineers because, after all, once a man is able to take care of his family, he achieves a great deal of pleasure, of professional recompense, for working in his field.

The scientist and the engineer who really does his job leaves a lasting monument. He can take pride in his accomplishments, and that is worth something, too. Money is not everything.

I think you have done pretty well with the present salary scale for scientists and engineers in Government. I will leave that and get on to teachers.

For our teachers we certainly do not do enough. We entrust the future of our children to them and yet treat them as second-rate citizens. This is where we could use some Federal money. You could set up standards for teachers, and urge them to qualify to these standards. Then I would have the Federal Government augment any deficiency in teacher salaries in those States which do not pay their teachers adequately. But this additional money should go directly to the teachers and not through State Boards of Education or professional educators—those who require our teachers to take courses in how to teach plumbing, fly casting, window opening, and such trash.

This is the pernicious thing that is contained in some of the aid-to-education bills. It is not all lack of money. Money could be spent better in helping teachers to become qualified to do their jobs. Then, if the States are not rich enough to pay them adequately, and provided the teachers can demonstrate proficiency, let the Federal Government make up the difference in salary directly to the teachers.

Mr. SISK. Do I understand you to mean that in the Federal education bill we might put some provision to provide for better paid teachers instead of, let us say, patios and swimming pools?

Admiral RICKOVER. Yes, sir.

I was at a meeting the other night in Baltimore, and a contractor who erects school buildings told me: "I tried to sell them the idea they can build some of their school buildings simpler and cheaper. It is going to hurt me financially to put up cheaper school buildings because my fee depends on the cost of the contract. Nevertheless the professional educators will not let me build the cheaper ones. They want to have expensive frills because they like to be in charge of fancy structures."

These educationists are pure administrators and they mostly think in terms of large facilities, not of intellectual matters. It is not

necessary to have large expensive school buildings. In the early days of the Atomic Energy Commission they found that they could not even put up a school building on a lump-sum contract. They put up a school building at Hanford, Wash., on a cost-plus-fixed-fee contract at a very high cost. This was eventually investigated by the Joint Congressional Committee—why a school building could not be built on a fixed-price basis.

I am not in favor of elaborate buildings. I would rather have a good teacher in a barn than a poor teacher in a palace.

Excuse me for sticking to this subject, but if Congress really wants to do the most important thing to help the United States, you would get after the question of teachers' standards and salaries, and what the pupils must know when they get out of school. I would have a national examination and I would have every child take that examination when he finishes high school, and see how well he does. Then his father and mother could tell whether the schools have done a good job.

Congress has set up laws for what goes into people's mouths, but you will not even provide for a recommendation for what is to go into their heads.

Mr. SISK. Admiral, I fully appreciate your concern with that. I think I have some concern on that score myself, as far as the direction the education program has gone.

Let's get back to the immediate future with which we are concerned in this space age in which we live, and that is the full utilization or what we may be able to do from the standpoint of Congress in fully utilizing the present existing scientific and engineering brainpower which we possess. We discussed the salary question because that was the first thing you mentioned. You actually wound up by saying that you felt we paid rather well as far as Government was concerned.

Admiral RICKOVER. Yes, sir.

Mr. SISK. Then somewhere a recommendation or a program to utilize fully this brainpower, which I think is important, can be developed.

Admiral RICKOVER. I do not think you can do this by legislative fiat, sir. It depends almost entirely on the man you put in charge. You cannot sit in a congressional committee and tell a man how to run this job. You can ask him questions; you can ascertain whether he does a good job; but you cannot put that into the law, because it is a subjective matter.

I urge, based on my own experience, that you do not let this new agency get started full blown. Let it get started modestly. Let it develop as circumstances warrant.

Mr. SISK. On the educational problem let me ask you this:

Going back into history a little bit, and referring to the fact that, as a country, we have a quite short history, we have created a nation that is certainly considered to be one of the leading nations of the world, and we have created a lot of good things for people. We have a lot of ingenuity, I think. You do not think that our education has always been wrong, but we have recently defaulted?

Admiral RICKOVER. I feel we have been living off our capital and not entirely off our current earnings. People came over to this rich, vast continent and have used its resources too wastefully, and without

enough consideration for our posterity. Our standard of living today is not based altogether on what we earn; it is based on using up irreplaceable natural resources. If we really lived on what we actually earned, we would not have so high standard of living.

The countries of Europe have had to husband their resources for the past 300 years and they found out the only way to get along on meager resources and still have a reasonable standard of living was to properly educate their people.

For instance, the countries of Western Europe have an educational system based on the lessons of 2,500 years of western civilization. In the past 50 years we, in this country, have broken with that system of education. We have gotten away, a great deal, from the basic rigorous studies: mathematics, physics, chemistry, science, history, languages. We have broken with this rich cultural past. The object of our public schools has become to make the children happy—"happy ants" as Senator Flanders says. Unless we change quickly and get back to training our youngsters in a rigorous, hardheaded manner we are in for a great deal of trouble. We must not permit our children to be deluded that life is all fun.

Mr. SISK. Do you agree with some of the testimony here before this committee a few days ago that actually we are still ahead of other countries of the world in basic research, astronomics research, and so forth, but actually today we may be behind in hardware? Do you agree with that statement?

Admiral RICKOVER. I am just a simple naval officer. When I see the Russians putting a sputnik in orbit with a payload much greater than we can get up, in my untutored and unsophisticated way I conclude that the Russians are ahead. I know of no other way to judge. So what I see is different from what I hear.

Mr. SISK. I go back to the question asked you by the chairman of our committee when we started the hearings this morning as to the peril which we face and the importance of the problem to the next generation.

I felt at that time that you were rather downgrading the importance of it.

Admiral RICKOVER. I believe you are touching on two separate subjects. I said that for the immediate future we are not going to find protection in space ships and space cadets. We are going to be protected by the military forces we have now and those we are now developing, particularly missiles.

I thought I made that clear—that, in my opinion we will develop operable missiles sooner than we will develop space vehicles which could be a controlling factor in warfare. This is what I mean.

The CHAIRMAN. My impression is the same as Mr. Sisk's of what you said, that you did not think there was so much urgency on the part of this committee.

Admiral RICKOVER. I said I did not think there was so much urgency for the space agency as there was in 1946 for the Atomic Energy Act. That was my comparison.

The CHAIRMAN. I think you failed to consider what I had in mind from the angle of the time element, because in 1946 and 1947 the Soviet Union were not anywhere near as far advanced, so far as we know, in the atomic energy field as we were.

Admiral RICKOVER. I believe we can get ahead with this job without very large expenditures of money at this time. I think it boils down to that.

Many of these new developments just take much time to accomplish. I believe you were talking about a crash program, whether we should enter into a crash program.

The CHAIRMAN. The word "crash" is used descriptively in the sense of an effective program, not a lagging one.

You know the history of the Manhattan project pretty well?

Admiral RICKOVER. Yes, sir.

The CHAIRMAN. You know there were many who doubted that that should be gone into.

Admiral RICKOVER. There is no doubt as to whether we should work in the space field.

The CHAIRMAN. I mean, many opposed the Manhattan project.

Admiral RICKOVER. Yes, sir; I know that.

The CHAIRMAN. And you know it was a gamble.

Admiral RICKOVER. Yes, sir; know.

The CHAIRMAN. I know, because I was one who had to help raise $1.6 or $1.8 billion in 2 fiscal years without the Hitler government knowing we were doing it. We were told at that time it might be $2 billion thrown down the drain.

Admiral RICKOVER. But you know, Mr. McCormack, a man is always put on the defensive if he opposes anything. Do not forget that. He is in an unenviable position. I certainly am not opposed to this new agency and its proposed work, you understand, but traditionally the man who is an optimist and supports everything that is proposed always comes off best.

The CHAIRMAN. We are not discussing that.

Admiral RICKOVER. You are discussing that, really. You say you are not, but you really are. It is difficult for a witness who tries to throw some balance into a discussion where many others talked about it in grand terms. It is an awfully hard position to be placed in.

The CHAIRMAN. It is just like being against motherhood.

The CHAIRMAN. Just to give you a little basic thought in my mind, as a result of experience. Of course in the legislative field we have experiences, too, and encounter many difficulties in the passage of legislation. I can remember the Selective Service Act, 3 months before Pearl Harbor, passing the House by one vote. I led the fight for it. Everyone who voted against that bill was just as good an American as I, but there was that difference of judgment.

One of the basic things, of course, that I advocate, whether right or wrong, is that if I am going to err in judgment in these days I prefer to err on the side of strength rather than on the side of weakness.

Admiral RICKOVER. That decision, of course, is one that Congress must make. I can only give you my thoughts.

I will try to summarize them.

I think this matter of space is important. It should be run by a civilian agency. It should get the money it needs, but I say you do not need a crash program, and I doubt that it will get ahead faster by appropriating large sums of money right away.

I would rather have the agency organized in a moderate way at first, have the people in it become partners with their own Joint Congressional Committee and then mutually work out what they have to do.

That is what I am saying. I am not against such an agency. I want to make that very clear.

The CHAIRMAN. You have clarified my thoughts with regard to your testimony on the urgency of creating by law the agency which will administer this.

Admiral RICKOVER. Yes, sir.

The CHAIRMAN. Mr. Sisk, may I ask one question without interfering?

Do you think from the view point of decision-making that the agency head should be on high level?

Admiral RICKOVER. You mean in the Government?

The CHAIRMAN. Yes, as close to the President as possible, access to the President.

Admiral RICKOVER. You might do this, but ultimately you get where every decision has to go to the President, and obviously that is not desirable.

The CHAIRMAN. He is the Commander in Chief and the President of the United States. We know his powers under the Constitution.

Admiral RICKOVER. I might suggest you start it off with the same status the Atomic Energy Commission has. That is a pretty good status, and I believe the President does pay a great deal of attention to it. Then see how it works out.

When you pass the act for this agency you must assume it is a trial piece of legislation. Start it out, give it standing, and see how it works out. Change it later on as experience indicates.

The CHAIRMAN. In the light of the experiences of the Atomic Energy Commission, with which you are well acquainted, if you had that knowledge and that experience 10 years ago would you put the Atomic Energy Commission on a higher decision-making level?

Admiral RICKOVER. No, the Atomic Energy Commission is high enough right now.

The CHAIRMAN. But the Atomic Energy Commission is higher than what this bill proposes. You know that.

Admiral RICKOVER. You asked me that question before, and I told you the decision to put it in the NACA has probably been made by people who had access to all of the facts. The agency could also be made a separate purely civilian agency, but this is something you have to decide.

The CHAIRMAN. That is true. But I mean, whatever agency it is put into, do you think they should be put on a high level so far as decision-making is concerned, and access to the President?

Admiral RICKOVER. We are dealing in a field we do not fully understand yet. I am sure everybody agrees with you that it is highly important and essential, so I would start it high up, give it as much standing as the Atomic Energy Commission. It needs no higher standing.

Does that answer your question?

The CHAIRMAN. Yes.

Admiral RICKOVER. You could do it one of two ways: You could set up a separate civilian agency or you could elevate the NACA—whichever one you wish.

The CHAIRMAN. I want you to answer the questions. It gives me evidence which I can then evaluate.

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Admiral RICKOVER. I would put it as high as the AEC, but that does not necessarily mean it has to be extensive, sir.

The CHAIRMAN. Oh, no.

Admiral RICKOVER. Again I get back to the fact that the importance of an agency is not necessarily measured by the number of people it has. This is the dilemma, this is the thing you have to watch. In fact, if you make it too large, you may harm it.

Mr. O'BRIEN. Will the gentleman yield?

Mr. SISK. Yes.

Mr. O'BRIEN. I would like to clear up my understanding, Admiral, of this urgency. I think I understood you to say that this problem is urgent, but you believe we would reach our destination quicker and more efficiently if we take the road labeled "Research" than if we take one just cluttered up with the hardware?

Admiral RICKOVER. That is right.

Mr. O'BRIEN. Is that right?

Admiral RICKOVER. Yes. Let the hardware come when we see we have something worthwhile. Let's not start in with hardware.

Mr. SISK. Is it your opinion then, Admiral, that the fact the Russians were able to put substantially greater amounts of hardware into orbit than we were was due to the fact that they are ahead of us on basic research?

Admiral RICKOVER. In the space field; yes, sir. It is definitely my opinion that the Russians are ahead of us in that particular field, and that was due to the vast amount of effort they have placed on research and development.

Mr. SISK. I think that is rather important in the light of some testimony we have had before, and I think it is fine to have disagreement.

Admiral RICKOVER. I am talking as a layman. I read in the paper that they placed in orbit an object several times as heavy as we are capable of. If there are two people in a prize fight, and the first one punches five times as hard as the other you say the first one is the stronger man.

Mr. SISK. I appreciate your statement.

Admiral RICKOVER. I do not care what other explanation you get.

Mr. SISK. There is one other line of questioning, Admiral, and I do not know to what extent you may wish to comment on this. If you do not desire to comment at this time, simply say so. That line of questioning is this: In view of your experience on the job you have to do—and have been doing very excellently, I might say—what do you feel might be the application of nuclear propulsion to space vehicles?

Admiral RICKOVER. You are aware, Mr. Sisk, this is not my specific field of responsibility. But I believe that ultimately if we do get space ships, they may be propelled by atomic reactors.

You know, of course, that not much thrust is needed to propel a ship in space. Nuclear power may also be used to launch space ships. It may be that the best way to launch space ships and then power them in space is by atomic energy. It certainly should be looked into.

Mr. SISK. Do you feel we are at present doing all we should be doing about development and research in that type of program?

Admiral RICKOVER. One never does enough in research on anything. That can always be said. There is a program underway. It has certainly not suffered from lack of appropriations. I think the problem is lack of adequate scientific and engineering manpower.

I am convinced from my experience in the Atomic Energy Commission that no one who has been able to prove he could do a job and was ready to do so was ever denied money by Congress.

Certainly, in my own field, Congress has been more than generous to me. I get all the money I ask for—all that I need.

How do you like that for a statement from a bureaucrat?

Mr. SISK. The concern I have is not whether it is the fault or lack of fault of Congress or someone else. I am concerned whether or not we are proceeding with the proper type of reactor program. I realize you may be hesitant to make some comments here, but I would appreciate your very frank statement.

Admiral RICKOVER. Have I demonstrated any hesitancy up to now?

Mr. SISK. I might say, Admiral, I appreciate your frankness.

Admiral RICKOVER. No, I am not hesitating at all. There are certain fields that just cannot be pushed too fast.

For example, the big problem in atomic reactors is the harmful radiation effects on materials. It takes 3 to 4 years of testing in a test reactor to find out whether a sample of material will stand up under radiation.

In a missile engine, the materials need only operate for a few moments, so the problem is vastly simpler from a materials standpoint than it is in a nuclear reactor. In a missile the material can be used at very high stresses; it can be partly destroyed, all that is necessary is that it last for just a few moments. But in an atomic reactor the materials must last for several years. So it is significantly more difficult materialwise and takes a much longer time to design and develop. You cannot just order the materials for a reactor to be developed; it takes time, and money alone will not solve the problem.

In the last 20 to 30 years we have improved the ability of some materials to withstand temperatures only a few hundred additional degrees Fahrenheit. The curve of possible increased temperature is flattening out.

It is an extremely difficult problem. That is why there is not more progress. There are materials that are good for every other purpose except in a reactor. Place it in a reactor and very quickly it swells. It loses its shape. It closes the heat transfer passages. It burns out and releases a great deal of radioactivity. It takes several years to find all this out. That is why it is not the kind of a job we can do fast.

Mr. SISK. Mr. Chairman, just one more question and then I will conclude.

Do you agree or disagree with the statement attributed to a prominent scientist that the problem of developing nuclear propulsion for a vehicle of this type would be easier to accomplish now than the development of the atomic and hydrogen bombs were at their inception?

Admiral RICKOVER. No. My opinion, for what it is worth, is that it will be more difficult to develop propulsion for a space ship than it was to develop the atomic bomb or the hydrogen bomb.

Here is why: In a bomb the most difficult part is the development of the scientific formula. The bomb designer does not have to worry about his materials lasting for a long time. They need last for just a very small fraction of a second. The development of power reactors is far more difficult from a materials standpoint than the development of the bomb.

Mr. Sisk. Thank you, Admiral.

The Chairman. Mr. Fulton.

Mr. Fulton. Admiral, we are glad to have you here, and we know the good work you have been doing out around Pittsburgh and in highlighting the nuclear submarine program.

You have been on the stand now an hour and 45 minutes.

Admiral Rickover. I am still going strong, sir.

Mr. Fulton. I would say that, from your remarks you would say that this program should be conducted on a basis of putting vehicles into space, regardless of military considerations; military considerations should come second, is that not right?

Admiral Rickover. That is correct, sir.

Mr. Fulton. Then you would say in order of importance, not of priority, that education in the United States to you is Congress' most important program. Secondly, the proper use of our United States resources is next, in your mind. And thirdly, the problems of outer space are probably last. Is that right?

Admiral Rickover. Yes, because if we solve our educational problem, we are then on the way to solving all the other problems. That is, we solve our resources problem, also. We cannot solve any of these problems unless we have highly educated and intelligent people. This is the basis for my priority.

Mr. Fulton. Your exposition is that the Manhattan project which later became the Atomic Energy Commission should be considered in this instance as an example for our national space program. Is that not right?

Admiral Rickover. That is correct, sir.

Mr. Fulton. And that, under the Manhattan project, one of the basic elements of it was that the authority and responsibility were centered, which you like?

Admiral Rickover. Yes, sir.

Mr. Fulton. You likewise emphasize the fact that this is a recent research and development program rather than a manufacturing or production program, do you not?

Admiral Rickover. Yes, sir; certainly at the beginning.

Mr. Fulton. Another point that you made was that you seemed to put more emphasis and more weight on the person who ran the program than the particular agency or structure by which the program was implemented.

Admiral Rickover. That is correct, sir.

Mr. Fulton. So, if a program is set up, you want a direct responsibility both to Congress and to, possibly, the President or the administration by any particular agency that is set up, so that we will not have an advisory committee wandering around and later causing us trouble. Is that about right?

Admiral Rickover. That is correct. He should have advisory committees, but the advisory committees should not be groups of meddlers, nor should they control him.

Mr. FULTON. And he should have a responsibility which Congress controls and the particular agency should control.

Admiral RICKOVER. Yes, sir.

Mr. FULTON. So that agency does not have to fight the advisory committee?

Admiral RICKOVER. That is right. In other words, you notice the gist of my testimony is I have placed a lot of faith in Congress.

Mr. FULTON. Thank you. May I ask then, when you suggest a Manhattan-type project setup, would you not have in mind a military man as head of the Manhattan project rather than a civilian of a scientist type, or a management type; is that right?

Admiral RICKOVER. It does not matter whether he is a military man or a civilian, a scientist or a manager. I do not think you can separate these things into pigeonholes. A scientist can be a good administrator, and an administrator may have learned a great deal about science so that he can run the job.

As rule, I would not put a scientist in charge because, generally, the scientist has used his time fully in scientific pursuits, and is not too familiar with administration. I certainly would not put a pure administrator in, a man who knows little about science and engineering.

Mr. FULTON. Would you put in a businessman or would you put in somebody in Government?

Admiral RICKOVER. I would rather put a man from Government in.

Mr. FULTON. Why would you not put in a businessman?

Admiral RICKOVER. The businessman has been trained to have a different set of values than are needed for this purpose.

Mr. FULTON. Would he not be competent to run a large research and development project such as this, which would have a great deal of management and many business contacts to make?

Admiral RICKOVER. Yes. He may have too many business contacts to make.

Mr. FULTON. It sounds as if you are suspicious of the businessman.

Admiral RICKOVER. No, sir; not especially. I am suspicious of everybody.

Mr. FELDMAN. Including yourself?

Mr. FULTON. Seriously now?

Admiral RICKOVER. The businessman generally comes to the Government for 1 or 2 years; you will never get this job done with transients in charge.

Mr. FULTON. How many men in the country do you consider are competent to head this agency for the large job of research and development that is to be worked out?

Admiral RICKOVER. There are not too many. I testified in your closed hearing I thought there were possibly 15 to 20 people in the United States who would be capable of handling a large scale research and development job of this sort effectively.

Mr. FULTON. But you would not want to submit a list of those names you felt were competent?

Admiral RICKOVER. No, sir; because there would probably be 173 million different opinions on a list of this sort.

Mr. FULTON. Then on the question of money, you would keep the money in low amounts, aimed specifically at research and develop-

ment, for scientific talent, and not for the production of military hardware. That is another point.

Admiral RICKOVER. Yes, I would keep the production of hardware at a minimum to start off with, because in order to make this hardware there must be a vast establishment. You can easily be wrong. So the money may go for the construction of large scale and expensive facilities and hardware.

I would use existing facilities, either governmental or industrial, if at all possible.

Mr. FULTON. Suppose that you put a space satellite or vehicle into orbit and put it out about 26,000 miles and gave it a speed to match the rotation of the earth. It would actually just stay over one city, would it not?

Admiral RICKOVER. Yes, it would. You could ultimately control a space vehicle so that it could stay over any particular part of the earth.

Mr. FULTON. So we could then actually, in the United States, put up space vehicles that would just go right around with the earth and remain over any particular city of the whole world all the time?

Admiral RICKOVER. Yes, sir; you could.

Mr. FULTON. And never move. Could you not do that?

Admiral RICKOVER. That is correct.

Mr. FULTON. How close do you think we could bring those to any cities of the world and not get into trouble on the ground it was invading their territory or causing them some qualms about their defense—100 miles, 200 miles?

Admiral RICKOVER. I have no particular idea about that, sir. You know that the present law goes back to Roman times, that the man who owns a plot of land owns everything above it and below it. The extent to which he owns it above and below has never been clearly defined.

This is an issue that should be settled from an international law standpoint. If you can settle that issue you probably will not have any more wars. You can then settle the business of disarmament, too. This problem of space may force a new look at other international situations. If we can solve this problem, we may be solving other problems, also. That is a major reason why it should be a civilian agency; a civilian agency can more readily lead to a peaceful solution.

Mr. FULTON. In your position, you would emphasize research and development to find out the scientific facts; you would then oppose at this time a shot at the moon for propaganda purposes or a hurry-up or crash program for a lunar shot, would you not?

Admiral RICKOVER. I would oppose anything for purely propaganda purposes. I do not think that propaganda ultimately does as much good as some think it does.

For instance, it is said that sputnik has propaganda value. The sputnik was a fact. Propaganda has nothing to do with fact; it has to do with distortion of fact.

Mr. FULTON. Did not the sputnik going up first impress you? Why should we not then in the United States try to get to the moon first before Russia does?

Admiral RICKOVER. I was impressed. But the real lesson of sputnik was not that the Russians were able to get an object in orbit 2 or 3 months ahead of us, but the fact that it became obvious to our people

that the Russians were able to get a much heavier payload up. That is not propaganda. It can be called propaganda, but it really is not. There is not distortion of fact.

Mr. FULTON. The question comes up, then: If you emphasize purely the scientific in the missile field and space vehicle field, would you do the same in the nuclear submarine field, because with Russia having over five hundred submarines at the present time and we having so few nuclear submarines, do you not think that we in the submarine field in the United States should start with a greatly expanded hardware program?

The point is this: If in the environment called the sea which is necessary to the United States in its security, you have an expanded program that is producing hardware of a nuclear type and a faster type of submarine, why then in the environment called air, and in space, which is necessary for the United States security, should we not have an expanded program of hardware?

Admiral RICKOVER. We started off in our nuclear submarine program with research and development. We did not build large numbers of nuclear powered submarines until we had proved them.

Mr. FULTON. Then in what period of time would you envisage that this program should greatly expand itself in order to have an array of missiles, or whatever they are, in order to meet anything that any foreign power might be able to throw against us?

Admiral RICKOVER. That would depend entirely on what progress we make in research and development. As soon as research and development demonstrates that a particular object could be put into production, I would do so. But I would not start in building large quantities of space vehicles until I knew what I was doing. This was our aproach in the nuclear submarine program.

Mr. FULTON. You would not, then, go into a program at this time of an ICBM with a nuclear warhead nor would you expand the guided-missile field on the intermediate range, 950 or 1,500 miles?

Admiral RICKOVER. No, sir, I did not say that. The missile field is much further advanced than the spaceship program. So is the nuclear powered submarine. We have considerable technical foundations on which to go ahead and take chances.

What I am trying to say is that we do not yet know enough about spaceships to go into large-scale production. I would want some of the technology to be proved before we get into a large production phase.

Mr. FULTON. You would not, then, try for a space vehicle that could be used for reconnaissance purposes at this time in, say, some quantity so we could see what is going on in the world?

Admiral RICKOVER. I would first like to find out if I could build one before I would start building large quantities of them.

Mr. FULTON. Thank you very much.

Mr. O'BRIEN (presiding). Mr. McDonough.

Mr. McDONOUGH. Admiral Rickover, I understood you to say that we were not advanced as far as Russia in basic research development.

Admiral RICKOVER. In this field, sir.

Mr. McDONOUGH. In space technology, you mean?

Admiral RICKOVER. We are not, sir.

Mr. McDONOUGH. That does not apply to atomic technology then?

Admiral RICKOVER. I am not familiar with the atomic aspects of

nuclear weapons, that is, the comparison between the Russians and the United States. It is my opinion that they are not any further advanced than we are in the nuclear power aspects. We see no evidence that they are.

I am basing my opinion simply on the evidence, on the evidence there is.

Mr. McDONOUGH. The reason I made that point is that General Medaris and Dr. von Braun both stated that we were equal with Russia in basic research and development.

Admiral RICKOVER. In this field?

Mr. McDONOUGH. In space technology and in the development of space exploration. They admitted that the operational situation in Russia was slightly more advanced because they had thrown a heavier satellite into orbit than we have. Now they are both right in the field, and I would say they ought to know.

I was a little surprised to hear you say we were not equal on basic research, because, after all, both the United States and Russia are certainly following along the same basic natural laws. We both know it. The throwing of a satellite into space by Russia is done by using the same principle that we do in this country.

Admiral RICKOVER. Mr. McDonough, my opinion is based entirely on what they have done. I have no other way of judging. What I see is different than what I hear.

Presumably General Medaris has information that I do not have. I only know from the published statements. As far as I am concerned, the Russians have done a better job than we have in this field, and I believe it has taken them many years to reach this point. You just do not do it by deciding today that next year you are going to place a heavy payload into orbit.

Mr. McDONOUGH. You mean they have done a better job in throwing satellites into orbit?

Admiral RICKOVER. In my opinion, they have done a better job than we have in research and development in space matters and in the related aspects of placing objects into orbit. That is why they were able to launch one with a heavier weight.

Mr. McDONOUGH. Both Dr. von Braun and General Medaris also admitted that we have the industrial know-how, we have the manpower and the technical and scientific brains in this country, if they are marshaled and coordinated. Do you agree with that?

Admiral RICKOVER. I am not sure about that. I am not so sure we have enough highly trained people to do some of these very difficult things; one reason being, we are tackling too many problems, and we are spreading our qualified people too thin; we are duplicating too much.

If there is any genius to what the Russians have done, it is that they have concentrated on a smaller number of what they consider essential items, and they do these well. Trained people are necessary to do a job well. There is a great danger that by tackling too many problems at one time our talent is dissipated. A certain type of drive is needed in a project that is going ahead and is meaningful. There is the need to train people, to have them become dedicated to the job; it is not numbers of people that count.

This is where we make a mistake. We depend too much on numbers. One good scientist or engineer is worth a hundred mediocre ones. We just cannot equate quality with numbers.

We must not delude ourselves that the Russians are not ahead of us in this field.

Probably General Medaris and Dr. von Braun know more about this than I do. I get the same type of intelligence you get, and what I see, as I said, is different than what I hear. As I have no other explanation, I naturally assume the Russians have done a better job.

I am familiar with what the Russians have been able to do in education in the past 30 years. That, to me, is proof of why they are ahead.

Mr. McDonough. How is the space technology in the Navy compared in progress to the Army and the Air Force?

Admiral Rickover. Well, space belongs to the Air Force, sir.

Mr. McDonough. You, however, have developed the Vanguard and shot that after several failures.

Admiral Rickover. How does the space research work in the Navy compare to the others? Probably the Army has done about as well in space as either of the other two services.

Mr. McDonough. We have the three major services all devoting a lot of attention to this matter, and there is competition there, and there is a certain amount of interagency jealousy, I suppose, in that competition as to who is going to be first with what.

Do you think this is a good thing, or should we concentrate this effort, put it under one command, one direct line of authority, and proceed that way?

Admiral Rickover. I understand the purpose of your bill, with which everybody seems to agree, is that the major research and development responsibility will be centered in one agency. I think you should do it this way. One agency can assemble competent people more readily than several agencies competing with each other.

I do not mean by that the military should play no part in it. When we get to the stage where we are producing military items, the military should have responsibility too.

Mr. McDonough. The bill provides for a board of 17, with one man from the Defense Department. Is that sufficient?

Admiral Rickover. I would have more than one from the Defense Department, sir.

Mr. McDonough. Would you have a representative from each one of the major services?

Admiral Rickover. No, sir. I was asked that question before. My recommendation is to let the Secretary of Defense decide what military members should be on the board. I would not specify that they must be from the Army, Navy, or Air Force.

Mr. McDonough. As the organization now exists, with the Secretary of Defense, Dr. Killian, and Mr. Johnson, do you think that organization is accomplishing anything at the present time?

Admiral Rickover. It is out of my field, sir. It is a new organization, and I am not familiar with what it has accomplished.

Mr. McDonough. You are familiar with nuclear power, having developed the *Nautilus*. Do you think that we can send a spaceship in orbit easier with nuclear power than we can with chemical power?

Admiral Rickover. Not at the present time, sir.

Mr. McDonough. Do you think we could send one with chemical power into orbit?

Admiral Rickover. Well, we have sent one up with chemical power, and we have not sent one up with nuclear power.

Mr. McDonough. I mean a space ship, not a satellite.

Admiral Rickover. Nuclear power for a space ship is certainly not developed at the present time for doing that job.

Mr. McDonough. Are you familiar with the chemicals that are used?

Admiral Rickover. I am generally familiar with them from reading technical publications, sir.

Mr. McDonough. That is all.

Mr. Fulton. Will you yield? Admiral Rickover are you getting around to this question?—is there a possibility that the Russians have developed atomic power to the point where they can send a spaceship into orbit?

Admiral Rickover. My opinion is they do not have it.

Mr. McDonough. Do you know?

Admiral Rickover. I do not know. It is my opinion that they do not possess it.

Mr. McDonough. First, you said the big thing in atomic power is radiation.

Admiral Rickover. Yes, sir.

Mr. McDonough. And to prevent radiation to the occupants of the spaceship is one of the big problems, plus the weight of the reactor.

Admiral Rickover. That is right.

Mr. McDonough. What would be the minimum weight, in your opinion, of a spaceship with one man?

Admiral Rickover. I am not technically qualified to answer that question.

Mr. McDonough. What is the minimum weight—you know more than I do about nuclear power. How much of a reactor would you need to send a spaceship up?

Admiral Rickover. My field is nuclear power for ships, where we use machinery which is heavier than we would use in an airplane or in a space ship, where we are limited to much lower weights.

The Atomic Energy Commission, in conjunction with the Air Force, as you know, has been working for some time on that problem. It has not yet been solved. I thought you were getting at the point that the Russians might have the capacity to launch a spaceship or place in orbit a very heavy object by means of nuclear power; my best judgment is that they do not.

Mr. McDonough. That is merely a presumption on your part; you have no assurance?

Admiral Rickover. Well, it is a presumption based on what we know they have done in the entire field of atomic power. We do not know that they do not have a nuclear powered submarine, but we have seen no evidence that they do.

Mr. McDonough. Just for speculative opinion, why do you think Russia has not shot any more satellites into the air since they shot the two, and there has been a long period of suspension there. We have three of them now, and they do not have anything. Why?

Admiral RICKOVER. I do not know. I imagine they may be working on placing something in orbit which surpasses anything they have launched so far.

Mr. McDONOUGH. Spectacular.

Admiral RICKOVER. Yes. But it needs to be more than spectacular, sir. If it is spectacular, it also means a great deal of scientific and engineering work had to be done to make it spectacular.

The CHAIRMAN. It might also surpass what they have heretofore done?

Admiral RICKOVER. Yes. I see no point to their placing additional missiles in orbit unless they were heavier or they wanted to get more information from animals or possibly from human beings sent up in them. I certainly believe they will try, as soon as possible, to get a human being into space and have him return to earth so they can find out what went on.

Mr. FULTON. Will the gentleman yield?

Mr. McDONOUGH. Yes.

Mr. FULTON. You have said that space belongs to the Air Force. As a fellow naval officer, I would suggest to you that it does not belong to any military service and does not even belong to the Americans.

Admiral RICKOVER. I was joking, sir. The simple way of dividing the world is to say that anything on land belongs to the Army, anything in water belongs to the Navy, and anything in air belongs to the Air Force.

Mr. FULTON. But when you get beyond the air out into space, to whom does it belong?

Admiral RICKOVER. Of course, this is the big problem and will come on us soon.

One of these days an object from space which has been launched by one country or another will land in somebody's backyard; then the problem will reach real proportions.

Mr. FULTON. So you really do not feel, then, that space is an object for military exploration or dominion, but rather it is a field for scientific exploration; is that not correct?

Admiral RICKOVER. Yes. I would like to see space considered as belonging to all nations, just as the high seas do. You cannot separate its military aspects from the purely scientific, the peaceful aspects, sir. They are intertwined. You cannot make a real distinction.

Mr. FULTON. You do not mean that either one of them is going to dominate space, but rather, under a general space agency which might be set up by Congress, there is to be developed a national space policy which is to be both civilian and military?

Admiral RICKOVER. That is correct.

Mr. FULTON. And if possible, under President Eisenhower's arrangement, our national policy should be that space should be used for peace and not for war?

Admiral RICKOVER. And I do hope we take advantage of this new element to help bring about peace, to use it as a bridge for peace.

The CHAIRMAN. May I interject?

Mr. FULTON. I am through.

The CHAIRMAN. To say that is the Lyndon Johnson policy, too, as enunciated by him weeks ago.

Mr. FULTON. Yes, but the Admiral would disagree with Senator Johnson I believe, in that you would have the United States develop its own space program and national policy and not do it under the United Nations or another international agency?

Admiral RICKOVER. That is correct. We have not even been able to agree on how to exchange scientific information with our own allies in Western Europe. Then why would it be wise to take on, at the outset, a vastly more difficult type of problem.

Mr. FULTON. So you would just have a United States national space policy, not an international one?

Admiral RICKOVER. I would start off today with the development as a function of the United States. I would try simultaneously to get agreement from all nations that space not be used for military purposes. As far as research and development are concerned, we will not get ahead very fast if we start taking everybody in on everything at the very beginning. Duplication in research is healthy—it is beneficial to have other countries working on the same thing in research. But I definitely would be for complete exchange of information in this field with everyone.

The CHAIRMAN. Mr. McDonough, are you through?

Mr. McDONOUGH. Yes.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. Admiral, right along that line, do you not think it is imperative that the nations of the world agree that outer space shall not be used for military purposes, and that an enforcible agreement be reached to that effect?

Admiral RICKOVER. Well, I, of course, agree with the first part of your statement; but if you know how to get an enforcible agreement, then you have licked the entire problem.

Mr. KEATING. Of course, I do not, but do you not think that should be our aim?

Admiral RICKOVER. Yes, definitely; and not only for space. Perhaps we can use space as a means for starting it. Perhaps it offers a new approach that can be used to trigger an agreement.

Mr. KEATING. Do you not think that our country should take the lead in that?

Admiral RICKOVER. Yes, sir. I would always have our country do that. Traditionally, the United States has taken the lead in trying to make peaceful arrangements with other countries—the various nonagression treaties and other pacts. That has always been our position. We were instrumental in getting the two Hague Conventions started. We certainly should take the lead.

Mr. KEATING. In that connection, would you not favor a congressional statement of policy similar to something which I have introduced, and others no doubt, to the effect that it is the sense of Congress that outer space should only be used for peaceful purposes?

Admiral RICKOVER. Yes, sir.

Mr. KEATING. Do you not feel that would have a salutary effect, both in this country and in other countries?

Admiral RICKOVER. It would have a salutary effect in this respect: That foreign policy is now almost the exclusive province of the President. It would be good if the chosen representatives of the people made such a statement of policy, to show how deeply our people feel about peace.

Mr. KEATING. Now I want to pursue a little bit more your statement in which you said, rather facetiously, as you say, that space belongs to the Air Force.

Do you look upon space as different in kind or simply different in degree from the air?

Admiral RICKOVER. I will go back to what I said earlier. The dividing line between military and civilian uses could arbitrarily be set at the altitude a missile reaches to travel a distance of 12,500 miles. That height is easily ascertainable. For a missile whose range is 12,500 miles there is a band of altitudes available for the missile flight pattern. The altitude chosen will depend on many factors. The interrelation of these factors will result in some maximum permissible altitude for a missile flight of 12,500 miles. The maximum height, probably in the order of several hundred miles could be used as a dividing line between the military and civilian utilization of the space lanes. The distance of 12,500 miles is the maximum distance a missile would be required to travel. The earth being 25,000 miles in circumference, 12,500 miles is the maximum distance between any 2 points on the earth. I would accept that height as the limit for military uses.

Mr. KEATING. As the limit?

Admiral RICKOVER. As the demarcation. It is not a scientific demarcation, but from a practical standpoint of delineating the difference between the military use and the peaceful use, I would accept that height.

Mr. KEATING. That is surface miles?

Admiral RICKOVER. Yes.

Mr. KEATING. How many miles is that straight up?

Admiral RICKOVER. It is several hundred miles up. I am not giving you the exact figure, but it is somewhere around that. For the missile to travel a distance of 12,500 miles it must go up several hundred miles, something on that order. It can be figured out exactly. I would make that the dividing line between the military and the peaceful uses.

Mr. KEATING. That is the first specific suggestion for a definition we have had.

Admiral RICKOVER. You are just as capable as I am of formulating a definition. You asked my opinion. I have given some thought to this matter.

Mr. KEATING. I am very glad to have you give it.

Admiral RICKOVER. You might possibly consider the figures as analogous to the 3-mile limit for international waters.

Mr. KEATING. But that does have the merit of being specific, that is, measurable?

Admiral RICKOVER. Yes, you can measure it because a missile fired under given conditions must follow a definite trajectory to reach 12,500 miles. I do not know what the exact figure is.

Mr. KEATING. It is readily computable?

Admiral RICKOVER. Yes.

Mr. KEATING. But not by members of this committee.

Admiral RICKOVER. Oh, yes, you could do it. I do not know what kind of a school you went to.

Mr. KEATING. Then you would say that of that area which we would designate "outer space" that that has elements and character-

istics which would make it different in kind from that area below that area, would you not?

Admiral RICKOVER. Yes, sir. This is an arbitrary definition, you understand, it is simply an idea. I am sure you can get other witnesses who could tell you, "Well, you can make the dividing line at the ionosphere or the stratosphere"; there could be many other definitions. This is simply an idea for marking the distinction between military and peaceful uses of space.

Mr. KEATING. In other words, if you were defining where the area would be limited to peaceful uses, and you were doing it on your own, you would fix it at that point?

Admiral RICKOVER. Yes, sir.

Mr. KEATING. We have had evidence here from both Army and Air Force officers, and now you are the first Navy officer to appear before us.

Do you believe that, in view of the fact that the rules and missions, the present services, do not contain anything about outer space as an area which could be a future battleground, that there should be a redefinition of the rules and missions of the three armed services?

Admiral RICKOVER. Now you are getting into the subject of reorganization. I though the subject of this committee was space. I prefer if I may, sir, not to get into any discussions on reorganization.

Mr. KEATING. I do not want to ask you anything you prefer not to answer.

Admiral RICKOVER. I would rather not, because this is a matter the Administration is handling in its own way.

Mr. KEATING. I did not mean to have my question relate to the reorganization act that has been recommended by the President. I did not mean it to have any relation.

Admiral RICKOVER. Because it does touch on that, sir, and I would prefer not to answer it.

Mr. KEATING. I would not want to press you.

Let me ask you this: With relation to this particular space agency which is envisioned in this bill, I agree with you about the unusual character of that section which says that this 17-man board—

may make recommendations to the President with respect to the appointment of the Director and the Director shall not be appointed until the Board shall have had a reasonable opportunity to make its recommendation.

Have you ever known of any similar provision in other legislation?

Admiral RICKOVER. I am not certain, but I believe the law setting up the National Science Foundation may have a similar provision. But the National Science Foundation has an entirely different function—it deals with pure research which generally has no urgency because you never know ahead of time what you will learn from pure research. In my opinion the new agency should not be hampered by such a large board which meets occasionally and also nominates the Director. This agency will have urgent development work to do, besides research.

Mr. KEATING. If you require that the Board make the recommendation in the first instance?

Admiral RICKOVER. Yes, sir.

Mr. KEATING. You would be inclined to think that would hamper it?

Admiral RICKOVER. Yes. The President is the executive. It is up to him to nominate the Director. He is at liberty to go for advice to

17 people or to 17,000 if he wants to. I do not know why you have to tie him down in this case.

Mr. KEATING. You place great stress upon the designation of the Director.

Admiral RICKOVER. Yes, sir.

Mr. KEATING. As perhaps the No. 1 and most important element.

Admiral RICKOVER. There is no other issue as important. If you get a good director who knows what has to be done and wants to do it, and who will not let obstacles stop him, you will get the job done—the board of 17 will not do it. In fact a large mandatory board may hinder him. A friendly congressional committee, which he will surely have, will be his greatest help and ally. This will certainly be the case for the first few years, and until the agency becomes "political."

Mr. KEATING. I gathered that overall in this legislation you have the feeling that the Director was not placed at a sufficiently high level or given sufficiently high authority.

Admiral RICKOVER. I answered that in reply to a question Mr. McCormack asked me as to whether the man——

The CHAIRMAN. The agency.

Admiral RICKOVER. Whether the agency or director should not have the same status as the Chairman of the Atomic Energy Commission. I am not discusing the dual job that Mr. Strauss the Chairman of the AEC has. That is, he is personal adviser for atomic matters to the President and also Chairman of the Atomic Energy Commission. But as I stated to Mr. McCormack it was my feeling that the head of the new agency should have as much status as the Chairman of the Atomic Energy Commission.

Mr. KEATING. That leads me to this question: Admiral Strauss, as the Chairman of the Atomic Energy Commission, as I understand it, does attend Cabinet meetings and could be said to have Cabinet status. Is that not your understanding?

Admiral RICKOVER. I think that is pretty much a personal relation with the President. The President has decided to have an adviser in atomic matters, and he chose Mr. Strauss because he has great confidence in him. But whether he does that or does not for this agency, should not, I think, be stated in the law. That is a personal relationship with the President.

Mr. KEATING. That is the question I have in mind. I personally feel that this is such an important area that the director of this agency should have the equivalent of a Cabinet status. Now, do you think that that is a matter for the President alone to determine or is it something to which Congress should give its attention as a guide?

Admiral RICKOVER. I do not agree with you that this agency at the present time should have Cabinet status. Traditionally, Cabinet jobs have not been established until after the need appeared. We started out with only four Cabinet members when the country was formed, and the number slowly increased. There has always been a definite need before a new one was created.

You may be doing a great deal of harm if you set this agency up too big and too vast at the start. The people who will run it may become too involved in the administrative aspects of the agency instead of doing the job itself.

I can tell you from my own experience it is pretty good to be unknown and small in the beginning, because then you can go ahead and get

the job done without others finding out what you are doing. When they find out what you are doing, they try to interfere and take charge.

Mr. KEATING. On the other hand, you can go too slow in this area.

Admiral RICKOVER. Well, presumably, the agency is going to have a committee to help it composed of people with the same good will as you have here at this meeting. They cannot do this job by themselves. If they are to do a good job they are going to have to depend on the congressional committee, that is their safety and their assurance—that is enough.

Mr. KEATING. You and I fundamentally differ about this point, so you cannot answer my question.

Admiral RICKOVER. Yes, sir.

Mr. KEATING. Then answer this question if you can: You said that in your opinion there perhaps were only 10 or 15 men—I think that is accurate——

Admiral RICKOVER. Some number like that.

Mr. KEATING. Some number like that who would be qualified to be the director of this agency, and you said you thought that man should come from Government. Why do you say from Government?

Admiral RICKOVER. I say from Government because you cannot take a man who has been in industry, with the philosophy he has developed, with the friendships he has made——

Mr. KEATING. We have covered industry. I am talking about science, public administration.

The CHAIRMAN. Education.

Mr. KEATING. Education, or some other field.

Admiral RICKOVER. You could if the man were good and he had made up his mind to stay on that job to his dying day. This is really the criteria. You cannot get a good job done in these fields unless the man feels he is to be there forever—and acts accordingly. I would like to see a politician——

Mr. KEATING. We have the shortest tenure of anyone.

Admiral RICKOVER. Well, this is a good chance for one of you to get a good job.

And I used "politician" in the sense that it is good to have a man who has learned how to get along with people, who can size them up, and who understands how to get things done. If you have a good politician and he made up his mind to stick around, he could do a good job.

Mr. KEATING. Well, you got a good thought there. We will have to pass that along to the President.

Admiral RICKOVER. Are you thinking about it?

Mr. KEATING. I want to deal for a moment with your statement to Mr. O'Brien in answer to, as he put it, a blunt question, and you gave a blunt answer. That is true all through the Armed Forces, is it not?

Admiral RICKOVER. Yes, that is true in the Armed Forces. Normally the people in the Armed Forces will put in a 2 or 3 year tour of duty.

I can tell you this categorically: It would have been absolutely impossible for me or the other people in my organization ever to have come near doing our job with that system of rotation. It cannot be done; we are just fooling ourselves to believe otherwise. This is why I chided Mr. McCormack about his 1954 report. He did a darn good

job in those hearings. But then he stopped, and this is what I have against him—he did not follow through.

The CHAIRMAN. How do you know we stopped?

Admiral RICKOVER. Well, I have not seen any results.

The CHAIRMAN. Just a minute. Ninety-five percent of the recommendations could be accomplished administratively.

Admiral RICKOVER. Yes; sir; they can.

The CHAIRMAN. All right, now, you had better go over to the Defense Department and ask them why they did not farm it out.

Admiral RICKOVER. I am sure you have more influence with the Defense Department than I have.

The CHAIRMAN. I am like yourself; I am an unrestricted individual. I do not have much influence anywhere, my friend.

Admiral RICKOVER. That's for the newspapers.

The CHAIRMAN. You would make a good politician.

If what you say is true about the report——

Admiral RICKOVER. I think you should have followed up on it.

The CHAIRMAN. Ninety-five percent, at least, of our recommendations could be carried out administratively. Legislation is not required under the organic act, and they could have been put into operation, or any part of them could have been put into operation.

Admiral RICKOVER. I think the only people who have read your report are you and I—and the stenographer who typed it.

The CHAIRMAN. Well, there may be a lot of truth to that. And I have a higher opinion of the hearings and the report after Dr. Killian was appointed as scientific adviser to the President, because there are over 22 pages of his testimony in the report, and it gave a little idea as to his thinking.

Admiral RICKOVER. I would like to compliment you, sir. You did a good job there.

The CHAIRMAN. I do not mind being chided when I am to blame, but your chiding should go right over to that department of which you are a very important part.

Admiral RICKOVER. Yes, sir; but you have greater facility in doing the chiding than I have.

The CHAIRMAN. Well, that is a question of fact.

Admiral RICKOVER. I will bet on you. I would vote for you on that.

The CHAIRMAN. I will say this much. You are one of the men who has been able to have a breakthrough where given responsibility and carried it out.

Admiral RICKOVER. I was never given any responsibility; I took it. That is what you want to achieve—to get people to assume responsibility.

The CHAIRMAN. You took it?

Admiral RICKOVER. I am not saying this in any joking manner either. No one has any final responsibility in the Defense Department.

The CHAIRMAN. I am informed by reliable sources, and this is with the most profound feeling of respect I have. I never met you until a few weeks ago in executive session—and today—that I can remember. I do not know why, but I was always on your side when there was a battle in Congress.

Admiral RICKOVER. Yes, sir; I know you were.

The CHAIRMAN. But they tell me that the laboratories you run and the functions you perform with those associated with you are about as efficient as can be humanly approximated.

Admiral RICKOVER. There is one way you can judge that efficiency. We are placing 100 percent of all our contracts today for the complete propulsion plants for our nuclear submarines on lump sum competitive bidding, and we have built up industrial facilities to do that without the investment of 1 dollar of Government money.

The CHAIRMAN. But more than that, you have created a spirit of dedicated men and women who are associated with you, which is important. As a matter of fact, you are looking ahead 5 years, are you not, at least 5 years on young scientists and others coming into your organization?

Admiral RICKOVER. Yes, sir. I hire none but young people just out of college who have not yet been spoiled by industry. I would not hire any of you because you are too old and you have learned too many bad things. You do not have enough potential.

The CHAIRMAN. There still are a few good qualities among us.

Admiral RICKOVER. Well, there are. You give us money.

The CHAIRMAN. I will let you carry on from there, Mr. Keating.

Mr. KEATING. Admiral, I agree that it is necessary for longer tenure than ordinary for an Army or Navy officer in the type of work you are doing, and having served, as many others have, in the armed services, and being shifted from here to there, I realize the merit of what you say.

Are you advocating that principle throughout the armed services?

Admiral RICKOVER. Yes, I think we tend too much in the armed services to use the time of the people to train them so that they can do every possible job. We simply cannot do that anymore. Warfare has become too complicated.

Mr. KEATING. The argument the armed services give is that you need flexibility, that the Army or Navy officer must have a knowledge of other areas in order to be a good one.

Admiral RICKOVER. Yes, every naval officer is supposed to be able to become a good diplomat, but no diplomat can ever be a good naval officer. That is what you mean?

Mr. KEATING. In general, by a slight oversimplification.

Admiral RICKOVER. When I was younger I used to believe, too, that if you were a member of the military, you had to train yourself to do every sort of a job in the world. But it is no longer possible to do this in the military any more than it is in industry or in Congress. You get on one or two committees and you stay on them a long time. That is why you are able to do a good job.

Aren't you just as smart as the military? You probably think you are smarter, and you probably are.

Mr. KEATING. Some of us.

Admiral RICKOVER. But in this age of specialization, you cannot do everything, and that is one of the things that is wrong.

During the time I have been in my job there have been six Secretaries of the Navy, six Chiefs of Naval Operations, six Chiefs of the Bureau of Ships. As each new one comes in, I must start from scratch going over and over the same things. You cannot blame them. They have got to find out, because they are responsible for making the decisions.

But pretty soon I get to the point where I am doing nothing but explaining, and when does the work then get done?

That is the dilemma one gets into. None of us mind having people with a real purpose come in to learn what we are doing.

The last time I testified I invited the members of this committee to see some of our nuclear ship models. I would like to have the opportunity to explain them to you because you have an important function. You have not seen the models because you do not have the time. But I believe it would be of help to you; it would give you a better understanding of some of our advanced technology.

Mr. KEATING. You are very frank, and there are many respects in which I know you are telling us correctly.

Admiral RICKOVER. We could do our job much faster if we did not have uninformed interference. This is one of the things you might try to do for this agency you are setting up: You might try from an accounting standpoint, to be a little more liberal on the expenditures of small sums of money. Don't let their time be taken up with trivia when they are trying to conquer space.

Mr. KEATING. I want to ask you two questions about this specific legislation.

I gather from the way you talked about it that the way you envisioned this agency—and you will correct me if I am wrong—is that you are in fundamental disagreement at the moment with section 6, which defines the functions of the agency in so far as subparagraph three is concerned, where it gives this agency the authority "to acquire, to construct, to improve, to repair, to operate, and to maintain laboratories, research and testing sites, and facilities" and so on.

Admiral RICKOVER. No. sir. I am not in disagreement.

Mr. KEATING. You are not in disagreement?

Admiral RICKOVER. I was voicing a note of caution—that they be required to certify, when they request new facilities, that they cannot find suitable existing ones either in industry or in another agency of Government.

The way I like to run my job is to have a minimum of people at headquarters, to place the work out to the field and not build up a large staff at headquarters. This is what I mean. The agency must have authority to acquire facilities but it should be used sparingly. They must, of course, be able to come up with requests for appropriations to acquire facilities, but the committee should be very careful to ask: Why do you need this? Why do you not use existing facilities or people? Because if they start in doing everything themselves, they will be swamped with the administrative aspects of the job.

Mr. KEATING. That is the paragraph which gives them complete operating authority, and you would not deny them that; in the basic legislation?

Admiral RICKOVER. No, sir.

Mr. KEATING. But you would caution the Appropriations Committee to watch that very closely?

Admiral RICKOVER. I would include a clause in the legislation that they try, to the maximum extent possible, to use existing facilities and people. It is not necessary for every Government agency to have its own empire.

Mr. KEATING. I think that is good advice.

Now, referring to this board, it is a 17-man board, and it does meet 4 times a year.

The CHAIRMAN. At least.

Mr. KEATING. At least four times a year. It is intended to be a temporary part-time group. Do I understand you to feel that it would be better not to have a part-time and to have a full-time board?

Admiral RICKOVER. I do not favor a large board, sir.

Mr. KEATING. Not that size?

Admiral RICKOVER. As you were asking that question, I was thinking about how the Russians go ahead with their large-scale projects, in which they admittedly have been able to reduce lead time. I am sure you will not find any board of 17 people meeting 4 times a year telling the man in charge what to do.

Mr. KEATING. They do not pay as much attention to boards there.

Admiral RICKOVER. I am certain of that. They pay more attention to results.

No, sir; I am opposed to this type of operation. I have seen a lot of it.

Ask the Atomic Energy Commission what impact their General Advisory Committee has had on the atomic energy program.

Mr. KEATING. How many are on the advisory committee?

Admiral RICKOVER. There are nine.

Mr. KEATING. Do you have an opinion on that?

Admiral RICKOVER. Yes, but I will not tell you.

Mr. KEATING. All right. We have the responsibility, and we believe we have, if responsibility exists anywhere, of framing legislation here. Do you think that there should be something in between, but that there should be a 3- or 5-man full-time commission to deal with the director—something in between?

Admiral RICKOVER. No, sir.

Mr. KEATING. What kind of a setup would you think right?

Admiral RICKOVER. I would have a director. I would provide for 1 or 2 committees to advise him, provided for in the law. You can even have the advisory committees submit their reports to Congress. This is done by the General Advisory Committee to the Atomic Energy Commission. They submit a report which also goes to the congressional committee.

Mr. KEATING. Of course, this board envisioned here is, I guess, something called an advisory board but—no, it is called the National Aeronautics and Space Board, and they have certain respects in which they circumscribe the director, and it says that the board must be consulted as to certain matters.

Admiral RICKOVER. Look at it from a practical standpoint. Here is this poor man trying to do a job with 17 experts who have their own opinions. If he wants to get his job done, he somehow or other has to satisfy this group of 17. Just like when a Congressman calls at my office and wants something, we act a little differently toward him, particularly if he is on the Appropriations Committee, than we do to somebody else.

The problem is to get the proper man and not hog tie him with a board. I would have one or more small advisory boards, but not a board sitting over him and telling him what to do.

The CHAIRMAN. That observation shows you are very practical, Admiral.

Admiral RICKOVER. Thank you, sir.

The CHAIRMAN. So you take into consideration position, friendships, and other things, about which I asked a question or two earlier.

Admiral RICKOVER. Don't forget, some of this politics rubs off, even on witnesses.

Mr. KEATING. He did not say he did anything, he just said he listened more carefully.

You have been very helpful. What troubles me is that we must not hamstring this director.

Admiral RICKOVER. I think you would practically hamstring him this way.

Mr. KEATING. And you are familiar with the language of this bill?

Admiral RICKOVER. Yes, sir, I am familiar with it.

Mr. KEATING. You think that particular element should be changed in some way.

Admiral RICKOVER. Yes, sir.

Mr. KEATING. Thank you.

Admiral RICKOVER. You might have 1 or 2 committees with a small number of people. I just cannot see a 17-man committee getting together 4 times a year and settling the affairs of an agency.

Mr. KEATING. I have strong reservations about that being the right way to go about it. I agree with you.

The CHAIRMAN. Of course, you have to consider the historical facts in connection with the NACA. As you know, it was set up in the early 1900's and did not have much experience, and the field was limited. The Board then created was above the Director as it is now.

Admiral RICKOVER. Yes, sir.

The CHAIRMAN. This bill changes it to where the Director then becomes the head of the agency and the Board is to advise.

Admiral RICKOVER. But you still have not made this clear line of division. What I am really advocating is putting a director in charge.

The CHAIRMAN. I recognize that, but I wanted to have the historical aspects in the record and the fact that now the Board is the head of the agency in the organization setup. It will not be under the proposal now before the committee.

Admiral RICKOVER. The Boards do not really run these agencies. They cannot.

It is just like the Board of Visitors at a service academy. The Board spends 4 or 5 days looking around. Then it has to depend a great deal on an Academy official who has been working on the project for months, to assist them with the report. You just cannot casually get into technically complicated matters and have a real technical influence on them. It cannot be done. The Director could of course use the Board as a means to help him, because when he gets these 17 members to sign something, it proves he has full scientific backing. This method is not unknown in Washington.

Sometimes administrators want boards for this purpose.

Mr. KEATING. You see, Admiral, the point I am making is that this says that the Board shall be consulted by the Director as to 4 specific matters, and those 4 matters are, for example, like any major change in policy.

Now, those are very important matters, and the Director must consult with the Board. I am not sure, but I think that might have the effect of hamstringing him, as you say.

Admiral RICKOVER. Your legislation should provide that he has to keep the congressional committee informed of what is going on. As I said previously, I would much rather have a congressional committee which puts in a good deal of time than any part-time board. So my recommendation would be to have a Director, have 1 or 2 small advisory boards, have the reports of the boards also go to the congressional committee, but do not set the boards up to have mandatory authority over the Director.

I would do still another thing: I would make absolutely certain that Congress gets full access to information from this new agency it is setting up. That is, this agency should be a true creature of Congress. You must make sure that this creature you are setting up and supporting will legislatively and financially be respective to your ideas and give you all the information you need to carry on your own duties.

Do you understand what I mean?

Mr. KEATING. Yes.

Admiral RICKOVER. I would insert that in the law.

Mr. KEATING. You would have them make a report to the Congress or at least to this committee?

Admiral RICKOVER. Yes. That is done by all commissions.

I would go further than that. I would spell out in the legislation that it is a creature of Congress.

I am discussing now the involved problem between the legislative an dthe executive about access to information. I would provide in the law that this new agency, set up by you, keeps you fully and currently informed, that it is your right to get all the information you ask of it, that it is not a privilege for Congress to get this information. Because you cannot do your job properly if you do not get all this information.

I do not see any reason for any fight between the executive and the legislative in a matter like that. I do not believe the separation of the three branches of government was ever intended to mean that Congress could not get all the information it needs in order to do its business.

Mr. KEATING. You have shown a very friendly attitude toward Congress today.

Admiral RICKOVER. Members of Congress are the only ones who have to run for office. The rest of us are all appointed.

Mr. KEATING. We have to run every 2 years.

Admiral RICKOVER. I understand. You are the only ones who stick your necks out. I don't stick mine out every 2 years; you have to.

The CHAIRMAN. Are there further questions?

Mr. Feldman.

Mr. FELDMAN. I think you indicated that the Government had a monopoly on people who might be qualified to fill the position of director of such an organization.

Let me preface what I am going to ask you by telling you that in World War I we had a relatively difficult job to marshal industry into a cooperative effort for the first time in history and create a large productive capacity. And the man who did that was a man taken from industry. I am referring now to Bernard Baruch.

Would you say we might be able to find somebody in industry just as dedicated as he was in order to do a corresponding job?

Admiral RICKOVER. You are asking several questions at one time. Let me see if I can answer them.

I do not think the analogy is entirely correct. Production is something that involves the use of factories and machines and the marshaling of facilities. An outstanding job was done, and it certainly was wise to place an industrialist in charge. But that was in wartime. The rules you use and the things you can do in wartime and the things that motivate people in wartime are quite different than those in peacetime.

The people who came in then knew they had to do a production job, they knew what the job was, they had the necessary priority, and they had everybody in the country solidly behind them.

But here you are marshaling brains and that is far more difficult than pushing production. I do not say that it has to be a man from government. It could be a man from a university. It could be a politician.

But I am afraid of a businessman coming in for a couple of years' tour of duty. I am afraid that just because he is an expert in running a business organization this does not necessarily make him an expert in doing a large-scale research and development job. The values, the objectives, and the methods in business are different than they are in government.

Some people in industry, for example, have reputations in research and development that are synthetic reputations. They are built up by advertising and by propaganda because it pays the company to do that. It casts glory on the entire organization.

Mr. FELDMAN. That could happen in any field, could it not, Admiral?

Admiral RICKOVER. You are really asking me this question: Who are the best people in our country today? Where do we go to get them?

I said government because there are a number of people in government who could do this. I said it does not make any difference whether they are military or civilian, it depends on their knowledge and ability to run things, and on an understanding of the aims of government.

Mr. FELDMAN. But you would not preclude a man from industry if you felt he had great managerial ability?

Admiral RICKOVER. No, I would not.

Mr. FELDMAN. In fact, a man from some of our large industrial concerns might be just the kind of a person who could cut through red tape.

Admiral RICKOVER. It is quite possible. I would not preclude anyone, sir. I tried to indicate I thought that on the average you would probably get a better job done by a man from government.

Mr. FELDMAN. I just wanted to clear up one or two things about the bill.

I believe, in your answer to a question by Congressman Brooks, that you stated it was necessary to set up a strong military liaison in the legislation itself.

Admiral RICKOVER. Yes, sir.

Mr. FELDMAN. Would you also set up a corresponding liaison with the AEC, which has a space program under way at the moment, or would you have the new agency take over the AEC facilities in this connection?

Admiral RICKOVER. The way I would handle it, I would let the AEC or any other agency keep on doing the work they do and not just try to take it over, but I would consider them as a contractor. Later on, if it became advisable or necessary to do so I might take the project over. But you do not have to have a liaison group with everybody with whom you do business. You might just as properly have liaison with U. S. Steel just because you use their steel, and you certainly do not need that.

If the AEC has facilities and people that can do a job, use them. If they do not do a good job, take it over, or go somewhere else, or do it yourself.

But the smartest thing that the man at the head of the new agency could do would be to take on the minimum number of technical responsibilities himself, and try to get other people to do as much as possible for him.

Mr. FELDMAN. If you need a liaison for the military, do you not need it for AEC?

Admiral RICKOVER. Not necessarily. The reason you need a liaison for the military is because you are planning to set it up as a civilian group, and the AEC is already a civilian group. There are military implications in this, and you want to make sure that the military are taken care of, and so you set up a military liaison committee to give the military this opportunity.

Mr. FELDMAN. How about the AEC—their facilities are equally important?

Admiral RICKOVER. The AEC is already a civilian agency. On that basis you would need a liaison group between any two civilian agencies in government. You have to presume that in the normal conduct of government business the people will deal with each other. The reason to make an exception in the case of the military is because it is concerned with defense. Also the military has been doing this work. In this way you tend to tie this whole thing together.

The Chairman. I take it you mean there should be cooperation between the AEC and all agencies?

Admiral RICKOVER. There is supposed to be anyway. There should be.

The CHAIRMAN. Is that what you had in mind, Mr. Feldman?

Admiral RICKOVER. If you start having too many of these liaison committees you will get into the same situation as with too many boards.

Mr. FELDMAN. Not necessarily. Could you set up one liaison operation to include both the military and the AEC, because of the AEC functions in this area? That might take care of both organizations.

Admiral RICKOVER. There is supposed to be liaison all the time between all branches of Government. You must assume that the Director of the new agency will arrange for necessary liaison whenever this is necessary.

Mr. FELDMAN. I am not talking about all branches of Government. All branches of Government are not concerned with space. The AEC is concerned with space—at least one branch of the AEC.

Admiral RICKOVER. They are only concerned with space to the extent that they are developing propulsion. The agency will have to go to other organizations besides the AEC to do things for them.

Well, you asked my opinion. Here it is.

Mr. FELDMAN. Admiral, we had some testimony from another witness stating that if we had a hundred scientists doing research we might get 10 good ideas as a yield from the work they were doing, or the research they were doing, and if we had a thousand it would stand to reason we might have a hundred ideas coming from the group.

You also stated previously that the Russians had this program of training a great number of astronomers and a great number of scientists, and very successfully. How do you reconcile that with what you had to say about having a small group of scientists? If we do not need to have a large number of scientists, why train them?

Admiral RICKOVER. I think you misunderstood me. What I meant to say was that the headquarters organization should not become too large, it should not have a large number of people, but should instead try as much as possible to have the talent in the external organizations. Otherwise the headquarters organization will become completely involved with administration, to the neglect of its real job.

Does that clear it up, sir?

Mr. FELDMAN. That does.

The CHAIRMAN. Are there further questions?

Admiral, we appreciate very much your appearance, and you have been most helpful. On behalf of myself and the other members of the committee, I extend to you our sincere thanks.

Admiral RICKOVER. I appreciate having been permitted to testify before your committee, sir.

The CHAIRMAN. You keep in mind what I said about editing your testimony.

Admiral RICKOVER. And adding to it.

The CHAIRMAN. Yes.

We will now recess and meet again at 2: 30.

(Whereupon, at 1 p. m., the committee recessed, to reconvene at 2: 30 p. m. of the same day.)

AFTER RECESS

(The committee reconvened at 2: 30 p. m., Representative John W. McCormack presiding.)

The CHAIRMAN. The committee will be in order.

We are very happy to have with us the next witness, Rear Adm. J. T. Hayward, Assistant Chief of Naval Operations for Research and Development.

Have you a prepared statement, Admiral?

Admiral HAYWARD. Yes, Mr. Chairman, I do have.

The CHAIRMAN. All right.

STATEMENT OF JOHN T. HAYWARD,[8] REAR ADMIRAL, ASSISTANT CHIEF OF NAVAL OPERATIONS (RESEARCH AND DEVELOPMENT)

Admiral HAYWARD. Mr. Chairman, members of the House select committee, I am Rear Adm. John T. Hayward, Assistant Chief of Naval Operations, Research and Development. It is the purpose of my statement today to—

(*a*) State the Navy's interest in space programs;

(*b*) Comment on the organization of a national space agency, and

(*c*) Comment on the problems connected with outer space.

During the past 6 months a great many words have been written and spoken concerning space exploration, space programs, and organizations to handle space problems. Among all these words there has emerged an implication, in certain areas, that the Navy is not interested in a space or satellite program.

This is absolutely untrue. This was particularly the case when I was having all the trouble with the Vanguard situation.

The Navy most definitely is interested in and desires active participation in a national satellite and space program. We consider that our interest would be best served by, and within, a broad program for space vehicle research and development of national scope and character.

The national space program should consist of both an integrated long-range effort establishing fundamental requirements and an immediate program utilizing existing and presently planned flight vehicles as a necessary part of the concerted national drive toward the exploration and exploitation of space.

It is the Navy's policy to support a national space program which will serve both military and scientific needs. The Navy has the strength, experience, and proven competence to make a major contribution to a national space program.

The following list highlights certain areas of Navy experience which are particularly applicable:

(*a*) Research and development experience in rocket and ramjet propulsion, particularly the development and application of solid and liquid propellent engines.

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[8] Admiral Hayward is Assistant Chief of Naval Operations (Research and Development) He was born in New York City on November 16, 1908. He graduated from the United States Naval Academy in 1930

His early service included sea duty on the U S S *Richmond* He was designated naval aviator on September 13, 1932, and subsequently served in carrier-based Scouting Squadron 1, Patrol Squadron 2, based on Coco Solo, C Z ; the aviation unit of the cruiser *Philadelphia;* and as senior aviator of the cruiser *Phoenix*.

Prior to and following the outbreak of World War II he served as assistant chief engineer (for instruments) at the naval aircraft factory, Philadelphia, and while so assigned had duty in 1940–41 as United States naval observer with the Royal Air Force. From December 1942 until March 1943 he had command of Headquarters Squadron, Fleet Air Wing 2, on the west coast He commissioned, then commanded, Bombing Squadron 106 in 1943–44

In June 1944 he became experimental officer at the naval ordnance test station, Inyokern, Calif, where he worked on all phases of rocket development and the development of, and study of destruction caused by, the atom bomb From July to December 1948 he was Director of Plans and Operations for the Armed Forces, Sandia Base, Albuquerque, N Mex, concerned with the use of atomic weapons and integration of military requirements with the Los Alamos Scientific Laboratory.

He was in command of Composite Squadron 5 from December 1948 until June 1951. This was followed by a tour of duty with the Atomic Energy Commission (Military Application Division), a year at sea in command of the carrier escort vessel *Point Cruz;* and command of the Naval Ordnance Laboratory from June 1954 to January 1956. He commanded the giant aircraft carrier U S S *Franklin D Roosevelt* from February 1956 until January 1957, when he became special assistant to the Director, Strategic Plans Division, Office of the Chief of Naval Operations In July 1957 he was ordered to assume the duties of Assistant Chief of Naval Operations (Research and Development).

Admiral Hayward has received many decorations including the Silver Star Medal, Legion of Merit, Distinguished Flying Cross, and the Purple Heart.

(*b*) Upper atmospheric research.

(*c*) Navy space flight research programs of the Office of Naval Research and the Bureau of Aeronautics.

(*d*) Knowledge and experience gained in the successful Vanguard scientific program.

(*e*) Aeromedical and space medical research; particularly the closed-space environmental physiology and psychology; and human stress tolerances.

(*f*) Radiation research.

The foregoing list is not all inclusive. It should be noted that 72 percent of the surface over which earth satellites or manned space vehicles will fly is covered with water. This immediately indicates a requirement for a Navy contribution to the national program in the form of strategically placed ships properly instrumented and equipped to perform such essential functions as mobile launching, tracking, data collection and analysis, control, and recovery. This important operation can be conducted under conditions of maximum security and without infringing the sovereignty of other nations.

The Navy has actively participated in research and development studies and experimental developments related to space travel since 1942. In fact much of the information gathered had a direct bearing on the establishment of the feasibility of creating a manmade earth satellite. In 1945 the Navy proposed that a satellite project be initiated.

This project was formulated on the basis that we could build rockets with sufficient performance which, when combined in clusters and stages, would be able to place a small payload into orbit. This proposal was finally rejected by the Committee on Guided Missiles of the Research and Development Board as not having sufficient military requirement.

In June of 1954 the Navy, with the cooperation and support of the Army, established a satellite program known as Project Orbiter.

This program was implemented, developed some component parts and had as its goal the placement of a series of satellites into an earth orbit, the first of which was to be a 5-pound sphere at 200 miles. However, in July of 1955, Project Orbiter was replaced by Project Vanguard as a result of a technical evaluation by the Department of Defense. Thus, Vanguard became our primary space satellite program.

Project Vanguard must certainly be considered as an unqualified success. Starting from scratch in October of 1955, a highly successful flight was made on March 17, 1958, which resulted in a satellite being placed into orbit. This performance is unparalleled in the history of United States rocketry.

The foregoing statements are made as evidence of the Navy's interest and successful history in space flight and earth satellites.

We believe that satellites and manned space vehicles can make notable and in some cases unique contributions to some of the Navy's standing requirements. Some of these requirements have to do with geodesy, navigation, weather forecasting, and communications; others are of a more classified nature. We fully recognize that our sister services have equally firm and similar requirements, thus it is inescapable that overall military requirements can best be met through a national program.

It is the Navy's desire and policy to take an active part in that program.

The prime function of the space agency, to be established by Congress, is development of a comprehensive program of research in space sciences and a national space program. We have an immediate and urgent need for a program that will serve both military and scientific needs. The legislative proposal to take over and enlarge the present NACA into a new agency called the National Aeronautics and Space Agency (NASA), is, in my opinion, the logical choice. There are several minor comments on the legislative draft as now written that the Navy feels would improve and clarify the functions of the NASA and these comments will be forwarded through proper channels for consideration.

The NASA has been compared to the AEC as an example of organizational efficiency. While there may be certain comparable aspects, the NASA will have a more difficult organizational problem and this must be recognized. It is comparatively easy to delineate the areas of cognizance within the AEC, on the other hand space technology cuts across almost every known area of research and development, including, perhaps nuclear power.

It is emphasized that the agency proposed would have directive authority rather than advisory, it is therefore of great importance that the delineation between civilian and military interests be made clearly and justly to avoid jurisdictional disputes.

Through the centuries military progress has been achieved by research with the military working side by side with the scientists. Each side has benefited from this relationship.

As the President's Science Advisory Committee reported—

> in fact it has been the military quest for ultralong-range rockets that has provided man with new machinery so powerful that it can readily put satellites in orbit * * * In this way, what was at first a purely military enterprise has opened up an exciting era of exploration that few men, over a decade ago, dreamed would come in this century.

Although there are some military applications in satellites that are readily recognizable, other applications are not. However, there is little doubt that future developments in space technology will open new possibilities.

We are aware that it is a military responsibility to assure that full advantage is taken of the military potential of space.

We must assure that space is not used to endanger our security, we must be prepared to use space to defend ourselves if that is the best method.

Consequently, the military and civilian aspects of outer space are inseparable.

Finally, gentlemen, a word of caution. The space agency must plan its program as a part of a balanced national effort in all science and technology—the correct balance of emphasis must be sought. The national space program should be treated sensibly as a most important but not the only important program in the Nation.

The timetable established by Dr. James Killian and his fellow scientist is most appropriate—"early" "later" "still later" and "much later still" and within this timetable, we must continue to stand ready to cope with any threat and carry out all missions assigned.

I would like to add to this statement by saying: In the space business one must always remember the definition of the national strategy of the country, which is the use by a country of the political, economic, psychological, and military forces in peace as well as war to attain the national objectives.

It was quite obvious that the Soviet recognized this definition of strategy, for the reason last year when they put up the sputnik, this was a marvelous example of the psychological forces of the country to further their objectives.

We must never forget this definition of "strategy," because it has a great deal to do with the space agency and the fact that anything we do in it does have a psychological effect on the rest of the world, and it helps us to obtain our objectives.

The CHAIRMAN. In view of the fact that Mr. Fulton is leaving shortly for Pittsburgh, without objection the Chair will recognize Mr. Fulton to ask a few questions.

Mr. FULTON. I want to compliment highly, Admiral Hayward as the head of naval research and development for his excellent service to our country in his capacity.

Also I want to compliment Admiral Hayward and his associates for their part in the two electronics breakthroughs that are amazing in the broad new fields that are open.

Before I ask the two questions, I would like to point out that there is no description of methods, calendar, no designation of programs by name, place, service, or type of equipment.

The questions are these: On current research developments, do we in the United States have it within our power soon to monitor the whole world, including countries behind the Iron Curtain, through electronic processes of ion emission.

Admiral HAYWARD. The answer is "Yes."

Mr. FULTON. The second question is this: Don't we in the United States have the capability through electronic means soon to use the moon as a means of reconnaissance so that we don't have to wait for production of satellites in orbit or a moon shot or a landing on the moon.

Admiral HAYWARD. The answer is "Yes."

Mr. FULTON. Thank you very much. That is all.

The CHAIRMAN. Would you elaborate on the answers to both these questions?

Admiral HAYWARD. Mr. Chairman, I could. It would have to be in executive session, however.

Mr. FULTON. Those questions have been cleared by you in that particular form and I have read the questions to be exact.

Admiral HAYWARD. Yes.

The CHAIRMAN. I think after the hearing is over we ought to have a brief executive session. Is that agreeable to the members?

(Unanimous assent.)

The CHAIRMAN. Mr. O'Brien?

Mr. O'BRIEN. I would like to reserve my time.

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. Not at this time.

The CHAIRMAN. Mr. Metcalf?

Mr. METCALF. Thank you, Mr. Chairman.

I am pleased, Admiral, that you have made a recommendation as to how this organization is to be set up, and I say that the NASA is a logical choice. That is one of the things that concerns this committee. When you say it is emphasized that the proposed agency would have directive authority rather than advisory, I am assuming you are referring to section 6 (a) paragraph 2 of the President's proposed bill which says that the "functions of agencies should be to plan, direct, and conduct scientific studies," and so forth.

But the directive authority, as I understand it, would be in the hands of the director rather than in the hands of the board created, is that correct?

Admiral HAYWARD. That is correct, sir. I have looked at this legislation quite closely, checked it with the President's message and compared it to the legislation establishing the NACA.

The Director of NASA is to be appointed by the President by and with the advice of the Senate. Whereas, today, the NACA Director is appointed by the Chairman of the Committee, which is a fundamental difference. The Director of NASA should have the authority, and he should have the responsibility.

The NACA today does not normally buy vehicles. The Navy and the Air Force in the X-15 program procure the vehicles for the NACA. There is a broad responsibility proposed for the NASA agency that goes further than what the NACA has today.

I don't think this is wrong at all. There is a great sense of urgency in this business and it is not limited to just the space business. It goes into technical training and research and development. When you see what the Russians are doing today, it upsets me no end, because the effort that the Russians are making is something terrific and every American should know that it is not going to be just 1 year or 10 years, but a long, long time.

And we will have to make a national effort of this kind across the board, not just space.

The Russians make their technical decisions at a very high level. One of the things that worries me, and I have been in the research and development business for a long time, is that we don't have very many technical decisions made at a high level.

Let me give you a good example. The National Presidium of the Soviet, which is the cabinet level, sits opposite the National Academy of Soviet Science. Back in the 1940s—1945, 1946—it was at this level that the Soviet decided to go to the ballistics missiles field. Now, in our country, such decisions are made at a much too low level. The Department of Defense, and I am in the military of course, makes such decisions and this is too low a level. I feel that we have to have competent technical people at the highest level to sit in on these basic research decisions.

I would like to see the very able Dr. Killian, let me say, legalized; and his authority defined. When we look outside the Department of Defense today, we see the National Science Foundation, the Atomic Energy Commission, the Bureau of Standards, and now, perhaps, the NASA. And I feel that one of the things that should go along with this legislation—or maybe it should be separate—would be something that would tie all of these technical agencies together in the Government under a competent technical man; if you want to call him "Secretary of Science,"—that is fine.

This "Secretary of Science" should sit at the level of the National Security Council. As an example, look back over the history of the Vanguard.

Now, I am not belaboring past decisions. And of course I could have even a shorter tour of duty than Admiral Rickover was talking about if I say the wrong thing.

But that decision that we were not interested in the Vanguard, that Vanguard was going to be the scientific IGY satellite, and it was not to interfere with the missile program—what technical people, what competent real scientists sat at that level and made that decision?

And in this meeting he showed you, well, maybe we didn't understand the psychological side of the national strategy.

So, I am all for putting competent technical people at as high a level in my Government as I can. The National Presidium of the Soviet, 60 percent are graduate engineers.

Look in Congress. They are all lawyers, or practically all. Maybe we have some chemists. I don't know. But they are not many. And you are having to make decisions on technical programs that involve our entire future.

So I feel very strongly that we should do something along this line. This is good. This is a step in the right direction.

Mr. METCALF. Perhaps you feel we are not putting the director high enough in the machinery of Government in creating this NASA. Maybe he should be a secretary in the President's Cabinet.

Admiral HAYWARD. That is right. Maybe he should be the secretary of science. When you do this, you should also bring in the other physical signs of the scientific parts of the Government.

Why aren't they tied together? You have the Bureau of Standards. You have the AEC. You have all of these agencies. I was with the Manhattan District when we—the AEC came into being. Now, the AEC has had a very fine and excellent history of good basic research. They do an awful lot in the physical science business that has very little to do in some cases with the atom as such.

I feel that we have to give due recognition to the technical side of life at the highest level in our Government.

In our Government we don't have that today. When you look at the Russian system, the Russian effort, it is surprising to me that our people can relax one moment. Now we have a couple of satellites in orbit, everything is fine, we will try to go back to life as it was. But life will never be the same again.

While I agree with Admiral Rickover that the research side of the house doesn't cost much money, this is going to cost terrific effort. It is going to go all the way down to the educational side and across the whole life of the American. And we have to realize it.

I think it is your duty as Representatives of the people to get it across to the people, that it is not something that will go away with wishful thinking. We just can't buy another car this year or something of this kind. So I am very strong for putting the technical people at the highest level I can, the competent technical people.

It is a very strange thing. When sputnik went up and everything was confused I made the same proposal that you gentlemen have gotten legislation for now And I was slapped down pretty hard.

Mr. METCALF. Now, it is your idea that this Director who would be a technical man, would be the person with whom the ultimate decisions would rest, rather than the Board.

Admiral HAYWARD. Definitely. If he has the responsibility, he has to have the authority.

I think that you can make him responsible, and give him the authority. Of course if he doesn't do his job, you fire him.

Mr. METCALF. You want the responsibility for this program placed as high in the Government as possible, and in the hands of one man who is technically trained?

Admiral HAYWARD. That is correct.

Mr. METCALF. I just wanted to clarify my ideas of your recommendations, because I respect your experience, Admiral. And thank you for that.

I assume that some of these comments and suggestions that you say will improve and clarify the functions are going to include technical changes in the legislation?

Admiral HAYWARD. Yes, sir. I have a complete list, chapter and verse, of what the differences are and what we feel would help this legislation or make it more effective to do the job.

Mr. METCALF. Are you satisfied that this legislation gives adequate liaison and attention to the needs of the Navy?

Admiral HAYWARD. Well, once again, we are for a national space agency.

I think you should have more people from the Department of Defense. I don't hold that it has to be Navy, Army, and Air Force. One representative from the Department of Defense out of 17 is not enough. Just as a matter of record, the NACA, for instance, consists of 17 people appointed by the President today. Two are from the Air Force. Two are from the Navy. Two are from the CAA. One is from the Smithsonian. One is from the Weather Bureau. One is the Bureau of Standards. And then we have—well, a total of 10 Government and 7 civilians.

The Chairman is elected by the Committee, the President approves the 5-year term.

Now, under this proposed legislation, you do not have a stipulated quota from the services, and so the composition of the board is not guaranteed to enhance the collaboration with the services as recommended in the President's message.

The CHAIRMAN. What is that you said, Admiral?

Admiral HAYWARD. I was saying that as the legislation stands today, the composition of this NASA Board is not such as to guarantee collaboration with the services as recommended in the President's message.

I feel that it could be strengthened and that the Department of Defense should have more than one representative.

Mr. METCALF. The suggestion you have would include recommendations that you are making, so that there will be cooperation with the services in accordance with the President's message.

Admiral HAYWARD. Yes.

Of course, this morning the recommendation about the military liaison committee was a good one, that came from the Atomic Energy Commission Act.

That has worked very well, and there is no reason why it should not be carried to this Agency.

I think the setup with the Atomic Energy Commission is a good one. The Atomic Energy Commission is responsive to military requirements, we get in on all of the programs, and we help them.

I think that the military relationship you want with this Space Agency is similar to what you have with the AEC today.

Now, if you had this Secretary of Science, or whatever you call him, you could use the present military liaison committee that exists on the statute with the Atomic Energy Commission to be the military liaison committee with all of the science agencies outside the Department of Defense. There is no reason why this could not be done at all.

And it would be effective if we had an Assistant Secretary of Defense for Atomic Energy matters, then he could be responsible for science matters. This would make sense and would save people, incidentally, too.

I think that the legislation would be improved in this manner.

Mr. METCALF. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Do I understand, then, that you think that the proposal in the legislation concerning the 17-man board would be all right if there were some adjustment in the personnel?

Is that what you are saying?

Admiral HAYWARD. That is correct.

However, if you do what we are talking about in the military liaison committee, I would just leave the Board as it is.

Of course, having started with the Commission, 17 is an awful lot of people.

Mr. SISK. That was going to be my next question.

Admiral HAYWARD. That is too many for my money.

Mr. SISK. In view of the testimony we have had heretofore, that a so-called advisory board, which might meet four times or more per year, would not be the type of board, maybe, that we should have, and it is on that point that I want to find out what your thinking is.

Should we have a commission similar to the Atomic Energy Commission where you would have 5 full-time people or 4 full-time people, or whatever it might be?

Do you think this 17-man advisory board or 11-man advisory board or 9-man advisory board, as an advisory thing, is really good?

Admiral HAYWARD. I think that a 17-man advisory board is too many. I feel it should be brought down. And if you have any doubts about the authority of this Director, he is going to be a real powerful man in the scientific and technical field.

Maybe it would be better to go to the commission-type of thing, such as the AEC. My feeling is that we should tie all of these sciences together. However, this is difficult because you have labeled this legislation "space."

From a technical point of view, everything we do in research and development can have application to the AEC, the Bureau of Standards, the National Science Foundation, and this organization. I think they should be tied together.

I do not see why it is wrong to tie them together. I do not think it is too big a job. And if you are going to have this 17-man committee, maybe it could serve better as an advisory committee to all of the technical agencies, outside the Department of Defense, under the Secretary of Science. You have the Chairman of the Atomic Energy Commission; a Director for this NASA, a Director of the Bureau of Standards, and a boss man on the National Science Foundation.

Mr. SISK. For the moment, then, let's talk about this Director.

You feel that there should be a much greater recognition of this overall program or this agency or this director—if you will permit me to put it that way—that they should be upgraded insofar as Government is concerned.

Where in the scheme of things would you put this director. Would you put him under the direction of a commission, or would you make him more or less a czar? Would you put him at Cabinet level? Would you put him subject only to the President?

Just how would you fit him into the scheme of things, Admiral, at this moment?

Admiral HAYWARD. Well, I would do this: My statement about the Russians you might misinterpret a little. I say we need at our Cabinet level a competent technical man, and I call him, for want of better words, "the Secretary of Science."

This Director, NASA, would work for the Secretary of Science. Also the Chairman of the Atomic Energy Commission and the boss of the National Science Foundation would work for him.

The Secretary of Science could sit on the National Security Council, would participate in its functions and would make—well, it would be his job and responsibility to make basic decisions such as, in the case of Vanguard, he would have said, "Gentlemen, it does not make sense to do this."

Mr. SISK. I see. That is fine.

That is why I wanted to get your ideas.

In other words, you still feel that we need a high-ranking man at the Cabinet level, or a high-ranking man to whom the Director of this agency, as well as the other agencies, would report and to whom they would be subject?

Admiral HAYWARD. Yes, sir.

Mr. SISK. Let me ask you this, Admiral: Just how serious do you consider this problem to be, as a matter of priority?

Where would you place this whole program of space exploration? Do you think it is imperative, that it is an urgent program, and that we should put a lot of urgency back of it?

Admiral HAYWARD. It is a tremendously urgent program. However, I do not confine it just to space. I confine it to the challenge that the Soviets have made to us; it is a battle for men's minds, you must remember.

I have made a study into all of the research and development that the Soviets are doing in all of the basic sciences versus what we are doing, and we are just not doing half enough.

The Russians, for instance, lead the world in, of all things, oceanography. They lead the world in mathematics. The Russians are instilling an understanding and a respect for the scientific approach

in all of their people by the teaching of science and using the high percentage of classroom time for this sort of thing regardless of whether the student is going to be a ditch digger or whether he is going to be an engineer.

Now, we have made real good studies as to how and what they are doing. If you trace back all the way the 1920 and take, for example, one field, the electrification of the Soviets, which has had a high priority since 1920. This priority project has produced real results in educational programs, research facilities, and the creation of equipment and operating systems that meet their requirements.

Now, there is a very cute curve one could always draw. That is the kilowatts expended per person in any country versus the standard of living. In such a comparative curve, you will find that we stand No. 1, the actual energy used, per person, electrical energy. Now, you can pick a lot of other things too that would do the same thing. But the U. S. S. R. has recognized the importance of the, let me say, the research and development side of life.

As long ago as 1928 Tupelov and Sokovsky convinced Stalin that they had to change their system. Their system has changed completely from what ours is.

They had a centralized research and development agency in those days. When I say centralized, it was really centralized, as most communistic things were.

They convinced Stalin that they should decentralize. When they said "decentralize" they excluded policy decisions which would be made at the Academy of Science level; however, all of the other research and development institutes—and there are 775 of them—would have the responsibilities for the state of the art in whatever field they are working in, whether it is metallurgy, propulsion, aerodynamics, and that capitalistic decision was made in 1928.

They also have competition in designs and incentives. The results of people like Djurvich and Alushkin, who have won the Lenin prize 4 or 5 times; and that is $3,500 tax free in our country's money.

Of course, they do have a double incentive, as Admiral Rickover said; they either produce or get shot. If they produce, they are rewarded. If they do not, they get shot.

But their program is terrific. And the sense of urgency that I have is to do something in our country to really help the situation, to get it across to the people, and that it is one thing that, as I say, is going to be here the rest of my life.

Mr. SISK. Admiral, I appreciate very much your statement.

It seems to me, as I have listened to witness after witness, and particularly to your discussion here, that maybe some things in the past that I remember reading about as a child are coming true, that ultimately science and technology would rule the world. And apparently Russia, you feel, has awakened to that idea, and is putting it into effect.

We have felt that morality, justice, equity, and law would rule the world, and that maybe we are being forced to revise our thinking. Is that generally true, Admiral?

Admiral HAYWARD. That is true.

Of course, in the education field, I feel that—you know, everybody describes us as a democracy, and we are not a democracy; we are a republic, which is important.

I feel that in some of our education we have gone to the mediocre. Everybody has to get a high school diploma; nobody fails. In a lot of the schools you don't give the child the right to fail any more. If he fails, he will be back in that same grade next year. You have got too many people there now anyway. So you pass him.

I am sure as a father of five children I am well acquainted with that problem.

Mr. SISK. Just two or three questions, Admiral, in reference to your statement. I would like to ask this question: On the first page you mention a national drive toward the exploration and the exploitation of space.

Now, I assume that by exploitation, you have reference to, let us say, peacetime advantages that we might gain from space. Generally, is that what you had in mind there?

Admiral HAYWARD. That is correct.

Let's just take communications. We have lots of troubles with communications, and perhaps we can exploit space from this point of view. I firmly believe that the greatest advantages in the space business are purely scientific and learning more about our environment. The military application is very limited.

Mr. SISK. Now, over on page 2 under section (e) you referred to some of the problems and some of the things on which the Navy has done special research—in space medical research, and so on.

My question is: there is a limit to the stress that we can stand. To what extent do you feel that may limit our progress into space?

Admiral HAYWARD. Well, it can limit it terrifically.

Of course, you probably read of the submarine coming back from Europe submerged. If you have ever been on a submarine, you know that that is as close to being on a space ship as you can get. In the Polaris we estimate that the maximum time we can keep those people together in a place like that is about 60 days.

This may be your time limitation. Of course, the submarine is air conditioned. And we have hi-fi. And we have steak and eggs and movies. But, after a while even that gets bad.

So, this is why we have been very concerned with this. We have physical limitations right away in space flight. A man can only stand about 17 g. maximum without being killed, and if you exceed 9 g., it is pretty rough. So we do have physical limitations, and I am sure that some of our work is going to be limited by this.

Mr. SISK. Well, now, that brings up the question which I intended to ask. Now, you speak of 9 g. What is man going to have to stand? For example, I am sure you are aware that there has been some discussion around here the last few days about shooting or tossing a man into space.

Admiral HAYWARD. Yes.

Mr. SISK. And the importance of such an effort makes it more than a stunt. I think it is important. I disagree wholly with those who indicate that it was merely a stunt.

I wonder if you would comment with reference to the problems involved in getting a vehicle or capsule, or whatever a man may be enclosed in, developed so that he can stand the pressure of that shot.

Admiral HAYWARD. In looking at the proposals for space flight, including the 117L system, and some of the others, I feel that they are on pretty solid ground. As a matter of fact, they are limited to 9 g.

and well within the temperature limitations of man. They only go up to about 150 degrees and I think it is perfectly feasible to do this.

I feel that it is most important to follow from the X15 to the X15B, this is going to be your real approach to space. I am not about to volunteer for that first trip. Like Admiral Rickover said, I too have some candidates myself to go to the moon.

Mr. SISK. I yield to the gentleman from Kentucky.

Mr. NATCHER. One of the members of the other body recently called upon a group of physicists to state what they thought was wrong with our present program pertaining to our missile and space research programs. Are you acquainted with this record, Admiral?

Admiral HAYWARD. I am, yes, sir.

Mr. NATCHER. Briefly, I would like to read just 2 or 3 short paragraphs from this report. And I would like for you to comment on this portion that I read, Admiral.

> Recent startling developments have pointed out for all the world to see that we have fallen dangerously behind the Soviet Union in the development and exploitation of science in the national interests. This hard fact was not surprising to any one who has followed recent trends in the support and encouragement of Soviet science, including education, as opposed to our reluctance to place the proper emphasis on intellectual endeavors. Indeed the past few years have seen the emergence of an anti-intellectual climate and an atmosphere of smug self-satisfaction which places a premium on conformity and finds us woefully unprepared to meet the current challenge.
>
> The root of the difficulties in which we find ourselves is in the system that places the military in such close control of scientific research and development.

Now, Admiral, how do you feel about that statement?

Admiral HAYWARD. I will give you a speech on it.

Mr. NATCHER. You go right ahead.

Admiral HAYWARD. I will answer that by saying I do not know whether anybody on the committee can answer this question as to Who was the first American Nobel prizewinner in physics? I wonder if they know? Do you know who he was?

Mr. NATCHER. No, it so happens I don't. Who was he?

Admiral HAYWARD. He was a naval officer. Michaelson was his name. He made the first measurements of the velocity of light. The National Academy of Science was founded in the United States at the instance of the Navy. We had people all the way back to Bushnell who made the first submarine. You had my friend, Admiral Rickover, before you this morning.

Well, let me tell you my own history. I started in the Navy as a sailor. I did not graduate from high school. And I won the Lifesaving Medal, and President Coolidge appointed me to the Naval Academy.

Since graduating from the Naval Academy, I studied 3 years of theoretical physics, specializing in the Einstein theory at the University of Pennsylvania. I went to the University of New Mexico. I went to the California Institute of Technology. I went to Stanford. I went to the University of California.

I worked with Doctor Lauritson in the first propellant rockets. I worked for Doctor Oppenheimer. I was head of weapons research in the Military Applications Division of the Atomic Energy Commission.

I am not unusual in any way. We have very many military people who are very competent scientists. I am convinced in my own mind.

And I am sure—General Groves would agree with me—that we would not have had an atomic weapon today if it had not been for people like the late Admiral Parsons. I do not agree at all that the Navy has throttled research and development.

The Office of Naval Research was established in 1946 to fill the gap when the Office of Scientific Research and Development was closed after the war, and has given over 50 percent, or contributed money that is involved in over 50 percent, of the doctorates granted in the physical sciences in the United States of America since the end of World War II.

So, when they try and throw the cloak and say military is opposed to science and that we throttle research and development, I object very strenuously.

Mr. NATCHER. In other words, Admiral, you maintain that that statement is wrong?

Admiral HAYWARD. Yes.

Mr. NATCHER. Let me ask you about this group——

The CHAIRMAN. You are talking about the Navy?

Admiral HAYWARD. Yes, sir. The Navy has been a technical outfit ever since the country began.

The CHAIRMAN. Well, the Navy appreciated, I think, from the investigation we made in 1954, that we found the Navy was more streamlined, you might say, to the appreciation of the importance of research and development.

Admiral HAYWARD. Yes, sir.

I appeared before you, Mr. Chairman. I was running a laboratory for the Navy then.

The CHAIRMAN. You remember those hearings?

Admiral HAYWARD. Yes, sir, I do.

The CHAIRMAN. And they were very important hearings, although not followed much.

Admiral HAYWARD. I think, however, that the other services have some real fine technical people and have done a good job. And I do not buy the idea that the military throttles research and development.

I feel our record stands open and right today. For instance, in the Office of Naval Research, we have 1,500 contracts with nonprofit organizations, or universities, based upon purely scientific and research matters. We do not tell them what to do. They come in to us with their proposal. And I will say that in the world of science in the country today, I think the Office of Naval Research enjoys one of the best reputations in the United States.

Mr. NATCHER. Admiral, let me read you another statement. I imagine you will disagree with this statement:

> In the present age of advanced technology, the defense of a country depends increasingly upon the wealth of scientific principles available for creation of military devices by training and by delegated responsibility.
>
> The military people themselves cannot be expected properly to encourage and support fundamental scientific research. Military decisions must always be taken in terms of present defense and military strength of the immediate future. Long-range commitments to scientific research having no foreseeable application will always tend to be abused and sidetracked by the military directorate.

Do you disagree with that statement?

Admiral HAYWARD. Particularly, I disagree from the Navy's point of view.

Admittedly, Admiral Burke has to weigh the fact that he may have to go to war in Indonesia tomorrow. That is true. But the decision was made by the Navy when they formed the Office of Naval Research that we would commit at least 5 percent of the Navy budget to this area, to basic research and development. Since that time we have done that.

Now, this last fall, with the expenditure limitation and all of the program troubles we have had—which have been many—Admiral Burke made a decision that, as of the 1st of July this year, we would cut out everything but research and development. That was the last thing that was going to go.

So I feel in the Navy that we have an appreciation of basic research.

And admittedly I can see what they are pointing to; Dr. Bush and a lot of people have testified here about it. That operational requirements dictate what you do, and that if you do not have an operational requirement, you do not get something. But let me point out that the Polaris missile today, with the propellant that we have, is based on basic research that we did back in 1946 and 1947 in polymers when the polyurethane, and this sort of business, was developed. The reason we can make solid propellant missiles to be launched from a submarine today is based on our work and research.

Mr. NATCHER. Admiral, this group also recommended that a department of science and technology be created with full Cabinet rank, although a department of technology and science might be preferable.

Do you agree with that?

Admiral HAYWARD. Yes; 100 percent.

Mr. NATCHER. What about this further suggestion? The group also suggested that the United States open its laboratories to scientists from all over the world, thus converting the emphasis from space war to a conquest of space, and further that the United States should unclassify a great portion of its present material.

How do you feel about that, Admiral?

Admiral HAYWARD. I agree with that.

One thing that we lack in our country is the ability to take advantage of what a lot of the other people do. Even in our own sciences, this "need to know" business is wrong. Basic communication between scientists is necessary if you are going to get ahead. Let me say the opposition understands this. The Russians spend, I would say, roughly the equivalent to almost a billion dollars in our money a year translating every technical document that comes out of the free world—every one. Even Aviation Week, which I would not classify as a technical document. It is available to the intelligence agencies of the Soviet. And it is available to them to start and know what the state of the art is in our country. They do not go down the wrong streets.

In Russia, a man in my position would be able to press a button and say "Give me a translation of the American Physical Society Journal of October 1957," and it would come up.

If I tried to get a translation of this today, I would hate to tell you how long it would be.

Mr. NATCHER. I want to thank you for your defense as far as the Navy is concerned.

I served in World War II in that branch of the service that won the war. And I am partial as far as the Navy is concerned.

Thank you, Mr. Chairman.

The CHAIRMAN. That does not come within the jurisdiction of this committee.

As an Army man, I admire the Navy. As one who served in the Army, rather, I admire the Navy.

Mr. McDonough?

Mr. McDONOUGH. You have gven us some interesting things to think about here.

I don't disagree with you on your desire to promote scientific research and development to the ultimate. But I am wondering about the progress that, in your opinion, Russa has made over a long period of years going back to 1920.

If they have. I wonder why they weren't better prepared when the Germans advanced against them? They had certainly enough resources. And if they knew how to do these things why didn't they prepare to meet a situation of that kind?

Admiral HAYWARD. This is a good question.

As a matter of fact when you go back to 1928, if you look at their 5-year plans, they were always behind in what they were trying to do. Just remember since 1920 what they were attempting to do. It is a terrific accomplishment. These people have done a terrific accomplishment. Just terrific. Now they weren't ready for the Germans, no.

That is true.

Of course some of the equipment they had, some of the things they did weren't very good.

Mr. McDONOUGH. Well, in World War I, I worked with Russian chemists here in the United States on the development of the detonator—the warhead for torpedoes—for the Russian Government, as a matter of fact, right up in the State of Pennsylvania. We produced tetranitro phenol, which up to that time had never been produced in any large quantities.

TNT was supposed to have the highest ballistics test then.

TNA—you know what that is, and where it is used. The Russian Government was buying it from the United States. They weren't even able to produce it over there. They sent their own chemists here to check to see that the specifications were met insofar as the—well, to be sure that it was acid free, that it was transportable, that it met the ballistics tests that they wanted. And that, of course, gave me an impression as a young man that Russia was not up to it.

When we had to do this for them, I felt that Russia was not up to it.

Then, following World War I, or I think it was World War I—well, shortly after Lenin—and when the first two or three 5-year plans came along, they called for our engineers by the hundreds to come over there to set machinery. Our American engineers informed us that they couldn't with all the apparatus they had, intelligently inform these Russians how to place a piece of machinery on a level base so that it wouldn't rock itself to pieces when they put power on it.

They spent many, many millions of dollars building factories with American engineers. I don't know how recently, American engineers were called over there to do a lot of things; in extracting petroleum, mining of coal, in mine production, in factories, and so forth. I have been under the impression that the Russian people do apply themselves

pretty thoroughly to a project. But they apply themselves so thoroughly to some one project that they forget a lot of others.

I think that we, on a broader and more diversified scale, are better prepared to meet the demands of material production in the event of war than Russia is even today.

Now, from what you say you don't agree with me.

Admiral HAYWARD. Right today on the production side you might be correct. But you are just emphasizing the point I made. How far they have come in those 38 years. It has been tremendous.

Mr. McDONOUGH. That is right.

Admiral HAYWARD. Well, they are graduating 60,000 engineers now a year.

With the same, roughly the same, number of teachers that they have, and roughly the same effort, we only get 25,000.

Now, our strength has always been that we have got to be able to do more with less. Just looking at the curve, the rate of progress of these people, in 10 years we will be so far behind that is is going to be pitiful.

Mr. McDONOUGH. Well, I think we should be concerned about that. But I think we can do and have done more with less than they have. They have the 60,000 engineering graduates. And they are not all voluntary students like you were.

Admiral HAYWARD. That is right.

Mr. McDONOUGH. They are students designated by the Government to train in that particular line for the state. Their whole objective is materialistic. Maybe, as Mr. Sisk said, we are a little too sentimental in our beliefs. We have got a little justice and loyalty and morality and a little more freedom and want more freedom. And we have, true, the freedom of speech and of the press in this country, and we can't do things behind closed doors like they can over there.

Certainly few people in the world knew anything about the sputnik that was coming up. But if we were to attempt to try to put a sputnik in the air or a satelite, it is known months and months ahead.

So, are we leading in the direction of this race for science—and I don't disagree—I have been in science myself, in my earlier years, and I think we need more of it. In this race for science are we losing our way of life? Are we inclined to go off in that direction, to become materialistic?

Admiral HAYWARD. No, sir. I am convinced, you see, in my own mind, that the Soviet, as Admiral Rickover pointed out, have one idea in mind. That is to conquer the world. But not the way most of our people think. Not with hydrogen bombs. I don't think it is going to come to that. They realize and see, I am sure, that it is a fight for man's mind.

This is the struggle. And just look, you may have the hydrogen bombs up to the Capitol over here, but you still may lose all of the world except right here. And if you have done that, you have lost the world.

Look at the past 13 years. Look back, and you can see how naive we were that we saved Western Europe because we were the sole possessor of the atom bomb. This is what we thought. But while we were saying this and while we sat back and thought of it, we lost a whole continent. All we had to do was to read Mr. Lenin, and he told you that the closest way to Paris was through Peking. And we

didn't believe him. We sat with our atom bombs and said, "Oh boy!"

Mr. McDONOUGH. He did it with men's minds.

Admiral HAYWARD. He did it with men's minds. He is doing it with men's minds in the Middle East. When the sputnik went over, what happened? We lost psychologically. You could have hydrogen bombs coming out of your ears and it wouldn't have done you any good. So he realizes this. This is the point I am trying to make, that the United States has to realize that it is a battle for men's minds. And when it is a battle for men's minds they have to be educated. And, of course, one of the hopes I have is that they educate every Russian, because in education, maybe, they will come to see that maybe this isn't right.

Mr. McDONOUGH. We are straying a little from the jurisdiction of this committee, Mr. Chairman.

But these are interesting things.

I agree. I think that the education may create a Frankenstein for this type of Government that they now have, and the more they get, the better I would like it.

However, they have anticipated that.

Admiral HAYWARD. Yes, sir.

Mr. McDONOUGH. They have anticipated that to the point that they want to control the scientific mind, however old it gets, up to a mature age.

Now, insofar as the bill before the committee on the establishment of this Agency is concerned, I gathered from what you say—and I don't disagree too much with it—that you think it ought to be pretty much a straight line of command with not too much diversification.

Admiral HAYWARD. That is correct, sir.

Mr. McDONOUGH. And I think that we should have more than 1 person from the Department of Defense on that group, because 1 man isn't sufficient.

Insofar as the organization is concerned, of course, our space program isn't going to start with merely the establishment of this Agency. We have already started it. We are pretty far advanced. And in the work that we have done up to now, without any legislation from Congress, except for appropriations to go on with certain research and development programs, has there been, in your opinion, much duplication in the various services?

Admiral HAYWARD. Well, that is a good question also.

Of course as a physicist, duplication is not evil, per se.

I call it parallel lines of investigation.

Mr. McDONOUGH. All right.

Admiral HAYWARD. I really haven't seen very much. For instance, the Vanguard program and the Explorer program and the experiments that we have set up, I think there has been some duplication. Of course, one of the problems that faces us is for example, the dispute that has gone on between the Thor and the Jupiter. When the decision to produce something comes up, that is when you have to make those hard decisions. And that is why I want this technical man at the high level to say, "Yes, it will be this or it will be that." Because in the research and development side of the house, this is when you are spending little money compared to, for instance, $1.4 billion in the

Thor. How much have you got in Jupiter? You have $1.5 billion in Atlas.

But the question of where duplication comes in, is primarily important when you produce them.

Mr. McDONOUGH. Are we out of the experimental stage in those two projects?

Admiral HAYWARD. Having reviewed them, we still don't have a weapon.

Mr. McDONOUGH. We are pretty much on the right side.

Admiral HAYWARD. Yes. We are going to meet them.

Mr. McDONOUGH. If anything I ask is classified, you don't answer.

Admiral HAYWARD. All right.

Mr. McDONOUGH. Are we approaching the practical side of the development of a manned space ship?

Admiral HAYWARD. I would say the X-15 program and the X-15-B program make sense.

Mr. McDONOUGH. The X-15 is North American. Is the other Lockheed?

Admiral HAYWARD. 117 (L) program is the Lockheed one.

Mr. McDONOUGH. That is a spaceship?

Admiral HAYWARD. Yes, sir.

Mr. McDONOUGH. That is more advanced than the X-15?

Admiral HAYWARD. Well, this could be open to argument.

The X-15-B has got to come back on land. And as an aviator, this is more difficult.

Mr. McDONOUGH. I think that is all, Mr. Chairman.

The CHAIRMAN. Mr. Keating?

Mr. KEATING. Admiral, you said one thing that rather startled me and I just wanted to ask you about it, because I think these physiological elements that enter into taking a man up and bringing him back, of course, are tremendously important.

I served in India where our service was attempting to assist Congressman Natcher's service in winning this last war. And one day it got to 120° there. We all felt it considerably.

You used the figure 150° as the limit of human tolerance.

For how long a period is that?

Admiral HAYWARD. Well, actually we have had men in such conditions for 35 minutes. And of course some of the fire rooms in some of our ships have run as high as 140°.

Mr. KEATING. For a matter of hours?

Admiral HAYWARD. No. I would say an hour at the most.

The 150° that I gave you is the reentry problem. And that wouldn't last more than maybe 11 to 30 minutes at the most.

Mr. KEATING. I see.

In other words, this 150° was during the reentry period?

Admiral HAYWARD. Yes, sir.

Mr. KEATING. The hottest period?

Admiral HAYWARD. Yes, sir.

Mr. KEATING. For a matter of 10 to 25 minutes?

Admiral HAYWARD. Yes, sir. And we have run programs, and so have the other people, on just what you can tolerate in this line.

Mr. KEATING. Now just one question about this bill.

You have rather leaned to the idea of favoring a Department of Science.

Admiral HAYWARD. Yes, sir.

Mr. KEATING. I don't disagree. I am rather inclined that way. But is this an alternative. Should the director of this agency be empowered to participate in policymaking decisions at the very highest level—which I think he should—should he sit in Cabinet meetings; and with the National Security Council? Do you think he should be given that high a position?

Admiral HAYWARD. Well, if he is given that high a position, then you have to tie the other agencies to him some way. The AEC, the National Science Foundation. He should have the whole ball of wax. And he is going to be——

Mr. KEATING. Well, not necessarily. Am I wrong that the Chairman of the AEC now sits with the Cabinet?

Admiral HAYWARD. Yes, sir, that is right.

For instance there are things that are done in technology that apply across the board. You take the amplification of this molecular atomic stimulation and radiation business, this can apply to space missiles or submarines. So he would be mixed up in the whole thing.

Mr. KEATING. In other words, a Secretary of Science would have a much broader jurisdiction than simply the matters which would come under the purview of this agency.

Admiral HAYWARD. Yes, sir. Suppose, maybe 5 years from now, we have a way of going to the center of the earth. And then you will want to set up an underground agency. So this can go on and on. I think it is time we tied them together into the Secretary of Science, and I would bring them all together.

Mr. KEATING. Well, now, suppose we weren't ready yet—the country, or the Congress, or the administration—to create the office of Secretary of Science, as regards this particular field of activity? Do you feel this is important enough, that the Director of this agency should participate in policymaking decisions at the highest level?

Admiral HAYWARD. Absolutely; yes, sir. It is most urgent that he do.

Mr. KEATING. Let me ask you this: If you think that—and you do—should we provide something with regard to that in this legislation or should we leave it to executive decision?

Admiral HAYWARD. I would provide for it in the legislation.

Mr. KEATING. I would too.

Thank you very much.

The CHAIRMAN. Mr. Ford?

Mr. FORD. Admiral, I wholeheartedly concur in your comments in response to Mr. Natcher's reading of the report of the Senate committee recommendations.

I know rather intimately that the Department of Defense—Army, Navy, and Air Force—over the last few years has recommended substantially greater research and development funding programs than either the administration or the Congress have approved.

Included in those recommendations and in the discussions, the military services have sought repeatedly to increase basic research to a greater degree, in total dollars and in percentage, to that which was made available.

I don't believe that the scientists per se, or certain groups of them, can put a halo over their heads and condemn the military for their views as far as science is concerned.

I agree with your application entirely.

You mentioned that the Navy and research and development have people in about 1,200 private educational institutions. I believe the Army and Air Force is comparable, if you add them all together.

Admiral HAYWARD. Yes, sir.

Mr. FORD. I would like to explore just for a minute your comment where you indicated the technical evaluation by the Department of Defense in July of 1955 made the decision that Project Orbiter should be replaced by Project Vanguard.

Admiral HAYWARD. That is correct.

Mr. FORD. Now, as I recollect the history of that—I may not be entirely correct—wasn't there an 11-man committee.

Admiral HAYWARD. The Stuart committee, yes.

Mr. FORD. Which made that decision?

Admiral HAYWARD. Yes, sir.

Mr. FORD. As I recall, the vote on that committee was by a decision of 9 to 2.

Admiral HAYWARD. That is correct.

Mr. FORD. I don't recollect the membership of that group, but it is my recollection that there were more scientists on there than there were military people.

Admiral HAYWARD. There were no military people.

Mr. FORD. In other words that committee of 11 was composed of 11 eminent scientists.

Admiral HAYWARD. Yes, sir.

Mr. FORD. That was a very important decision.

Admiral HAYWARD. Yes, sir, it was.

Mr. FORD. It was a decision which, rightly or wrongly, had us as a nation not becoming first in getting a satellite into orbit.

Admiral HAYWARD. Yes, sir. But you must, in defense of the scientists, acknowledge that the National Security Council had ruled that we could not interfere with the missile program, so this had a great influence on those technical people as to what they could use. You must remember that Project Orbiter was essentially a Jupiter missile and so they were influenced by the NSC decision.

Mr. FORD. I admit that is an element in their defense. But I refer to the fact that you can't always put a halo over the heads of scientists either, because at least 9 out of 11 of them in this case made the wrong decision.

Admiral HAYWARD. That is correct.

Mr. FORD. As far as the psychological advantage for this country is concerned.

Admiral HAYWARD. That is correct.

However, in looking at the record—and I have had a look at the record of all of that—there were many eminent scientists that attempted to really argue with the NSC decision.

They were told that there was no sense in arguing with it; this was the decision.

As late as 1956, a group of them met and wanted to argue once again with the decision. However, there were some basic technical things that favored the Vanguard decision also.

Admiral Rickover was talking about payload and orbit this morning. This is not necessarily the whole answer. When you tell me about payload and orbit, do you mean that you left the last stage with it?

The Vanguard puts 20½ pounds of scientific payload into orbit. If you left the last stage with it, it would be up to 70 pounds. The reason you separate it is purely for the scientific reason. You want a sphere. You want to get the maximum you can out of this thing, from the experiment that you are designing.

Project Orbiter could not put in the instrumentation the scientific experiments that this committee thought should be done. And also with the IGY commitment, as you remember, at that time it was a purely unclassified approach to the problem.

I am not arguing—I agree a hundred percent you can't put a halo around scientists and say they can answer all the questions. Lord deliver us if they do; because there have been a lot of mistakes they have made too.

Mr. FORD. I thoroughly agree that nothing is more objectionable than Monday morning quarterbacking.

Admiral HAYWARD. That is true.

Mr. FORD. In most cases the people who seek to become Monday morning quarterbacks were in the stands and never played in the ball game. So I have little sympathy for those who sit up there and make comments subsequent to the ball game.

But at the same time I don't think that we should now—bearing in mind that they—the scientists—may have made some mistakes themselves—all of a sudden cloak them with this omnipotence. Because they are as infallible as laymen, regardless of occupation.

Admiral HAYWARD. I make a statement always this way: it is not always the best thing to take the best technical policy, Mr. Ford. But the people who make the decision should know what the best technical policy is; what the technical answer is.

Now, there are a lot of times when the best technical answer is not the best policy, such as here, you see. But what I want to know is, Did the people who made the decision really know what was the best technical one when they made the decision?

You see, I have a feeling myself that they didn't know that Orbiter would work when they made that decision.

Mr. FORD. Well, as I recall, the people who voted against the change from Orbiter to Vanguard were very well informed as to Orbiter's potential.

Admiral HAYWARD. That is correct. Dr. Furnas was one of them.

Mr. FORD. Yes, as I recall, Dr. Furnas, Assistant Secretary of Defense, was 1 of the 2 who so voted.

I don't recall the other one. But it is my recollection that he was someone connected with the Army research and development program.

Admiral HAYWARD. Yes, sir. He was out of JPL.

Mr. FORD. At least one of those people was highly informed as to the good potential of the Orbiter program.

And Dr. Furnas, even though he wasn't connected with the program directly, was in a position where he certainly had full access to all of the arguments, pro and con.

I don't like to prolong that; but I think we must guard against fluctuating as to who is omnipotent.

Admiral HAYWARD. Yes, sir.

Mr. FORD. And I don't place omnipotence in the science ad infinitum, any more than I place it in the military or in civilians.

Because I know that in this particular case there are many who certainly would have agreed that if there was any chance of delaying or impeding our missile program per se, that they would have sided with the decision 9 to 2.

Admiral HAYWARD. That is correct.

Mr. FORD. That we should not have taken Orbiter out.

Well, I gather from your comments that what you presented to us here is your own view as to the legislation, but you seem to indicate that perhaps the Navy's views will be submitted, officially, later.

Admiral HAYWARD. Yes, sir. That is my view. And it is the Navy's view. We are for this legislation with these changes that I recommend. And we will present this officially to you.

Actually I must say we are delighted—this is the way it should be done. It shall have a strong committee in Congress to back it.

Mr. FORD. I am concerned with the provision which says that there shall only be one—that is a minimum, from the Department of Defense.

The CHAIRMAN. Not less than one.

Mr. FORD. Yes, it says "not less than 1 out of the group of 17."

Admiral HAYWARD. Let's put it this way. It should be responsible to the military. You have two paths that you can go down. You can do it this way by putting maybe more than one from the Department of Defense or you can go down and have a military liaison committee like you did with the AEC. And actually I can see nothing wrong with this.

I mean, that legislation has worked very well. And that might be better because they work day to day, the Atomic Energy Commission.

Mr. FORD. Is that a permanent group?

Admiral HAYWARD. That is a permanent group; the Assistant Secretary of Defense in the atomic matters. They work day after day on all of the programs with the Atomic Energy Commission. They live with it. Where this committee is only going to meet four times a year, they are out in the field. In order to be responsive to the military I think you should go down to the Military Liaison Committee standard yourself.

As a matter of fact, under this legislation, is there any reason why you couldn't make the same Military Liaison Committee to the AEC the liaison committee to this Agency? I don't know.

Mr. FORD. From a practical working application of the AEC setup with the military liaison committee, do you have this problem of interservice rivalry, competition, and so forth?

Admiral HAYWARD. No, sir. On this committee—and I will say, which was established of course by the statute—the present Assistant Secretary of Defense is a retired Army general actually that runs this. We have representation. We have our own research and development programs that we feed into this group.

As a matter of fact, the atomic weapon business is one of the best run and the best coordinated businesses in this whole situation. This is one of the agencies that was brought up and started—you don't have anybody making their own atom weapons at all. You don't have this problem. They are very responsive to the military.

Mr. FORD. Taking this proposal here, you infer that maybe 17 members were too many.

Admiral HAYWARD. Yes, sir.

Mr. FORD. And you tend to indicate that one from the Department of Defense is too few? Don't we get ourselves in the position of trying to restrict the size and increase the membership of the military?

Admiral HAYWARD. No, sir. What I mean is: If this agency is going to be responsive to the military, and you depend upon this one representative from the Department of Defense who sits on a committee of 17, four times a year to find out what is going on and what they are doing, they are not going to be responsive. So that is 1 reason why 17 is too many. What are they going to do four times a year? Kibitz the Director, tell him this or that? Are they just going to cover matters of broad policy? Will they present the budget? Just where do they fit in and what do they actually do?

To be responsive to the military—and I think the intent, you see, is to have the NACA—that is very responsive to us. We have no problems with the NACA. But we live with these people, remember. Their laboratory is at Langley Field. Their high-speed laboratory is on Moffett Field. We live with them all the time. I am sure the intent of your legislation is to have this same thing occur with this agency.

The CHAIRMAN. It is vitally important.

Admiral HAYWARD. Yes, it is vitally important.

The CHAIRMAN. It isn't simply a question of commonsense in the world of today that there be that close relationship, it seems to me.

Mr. FORD. Does NACA have an advisory board?

Admiral HAYWARD. Oh, yes, sir. They have 17 people.

Mr. FORD. How many of the military are on the Board at the present time?

Admiral HAYWARD. Right now NACA has 17 people. Two from the Air Force. Two from Navy, two from Civil Aeronautics Authority. One from Smithsonian. One from the Weather Bureau. One from the Bureau of Standards.

Then you have the remainder of them, 7 civilians, and you have 1 from the Research and Development; and of course the Chairman is elected by the Committee.

Mr. FORD. Of course this new Agency may have a different relationship with the military, as I envisage it. NACA today does jobs for the military. Under this new proposal, the military will be, in many cases, doing jobs for NASA.

Admiral HAYWARD. That is right. When you say the NACA does jobs for us, they do all of the basic aerodynamic work. You take the area rule that we put on our fighters and everything else, the NACA is not in the production business. The NACA is a scientific job, and their work is available to my friends, the Russians, who translate all of their documents; they are also available to our commercial airliners, to anybody in the world who wants to go down there and pay 50 cents for discussion on the area rule or anything of that kind.

Now, this committee and the NACA—I happen to have sat on one of their panels. I was the Navy's representative from supersonic aerodynamics. We work very closely with them. In this legislation, I don't see anything in there—I am sure the intent, as the Chairman said, was to have this relationship continue.

But it certainly isn't in the legislation as it exists today. It should be if you are going to tie these two together.

Mr. FORD. From a personal point of view, if you had your choice between legislation which would set it up on the basis of the AEC program or the proposal here, which would you prefer?

Admiral HAYWARD. Well, having lived under Government by Commission, sometimes it can get pretty hard. I do like the directive that you do have a Director, and I would like to have a committee of maybe 5 or 7 people. Then I would tie the military into it with this MLC approach more than anything else.

Now, this agency in order to launch some of their things obviously are going to have to go to Patrick, or the Pacific missile range. So we are going to have to be tied in from a logistic point of view.

But I think here you have 17 men meeting 4 times a year. If this is the only responsiveness, is this DOD Committee on this 17-man committee, it isn't good enough.

It should be spelled out in the legislation.

Mr. FORD. Thank you very much.

The CHAIRMAN. Admiral, back in 1954 when the Riehlman committee made its inquiry, we were trying to inquire constructively as to some of the bottlenecks and the difficulties experienced in research and development. We found that a considerable part was due to personalities in connection with the background and training of honorable and dedicated men. And we made a number of recommendations at that time which we thought were improvements in the situation. One of the recommendations that I remember we made, was the advisability of the services offering encouragement to officers like yourself, and young officers, in particular, to make a career in the service of our country dedicated to science, and technology, and its various aspects, without imposing these constant changes in tour of duty, and even to the extent of creating a separate corps, if necessary, like the Army Engineers, where officers would have the opportunity to advance.

Has anything been done on that? Has anything been done along that line?

Admiral HAYWARD. Well, of course, we are short of them. We lose them, Mr. Chairman, all the time. I mean good ones. We can't keep them. There are just so many, really.

I am sure you are familiar with our program of education along this line where all of our officers practically go to graduate school now. But it is pretty hard. You take a class as long ago as 1937 that went to graduate school—and we didn't put enough in graduate school then, I will admit—of 20 people; today you will roughly have maybe 3 left. That is the attrition.

Those people—well, in my own case it is awfully tempting some time when you want to pay your bills and everything to take a big job outside. And we are faced with this. We have stabilized the tours of duties of our laboratory commanders which the Riehlman committee recommended. We have definitely made the civilian scientist our partner.

Your committee actually investigated my laboratory and asked the Army why they couldn't run it that way too.

Dr. Bennett was the Director of it and had the responsibilities. I couldn't agree more about the tour of duty business.

However, I would hate to separate it completely from the operational side, because actually I feet that having to go to the wars and seeing the problems faced by the people, a lot of times, is a great advantage.

Now, the OSRD during World War II actually sent their people out into the field to see just some of the conditions that were faced. So, if you separate them completely, I would be more bothered. But I have to agree with you that we could do a lot better in keeping the tours of duty at, let me say, a much greater length of time.

I realize I might be sentencing myself to stay in Washington from now on, Mr. Chairman. And of course the tenure of life of the heads of research and developments of services has gotten to be very short.

My son said, "General Gavin has quit, General Putt has quit. When are you going to leave, Dad?"

I agree with Rickover on that. We could do a lot better.

The CHAIRMAN. Our investigation was not for sensation. You remember that.

Admiral HAYWARD. I realize that.

The CHAIRMAN. We weren't looking for some things to nibble at every human mistake. We weren't looking with hindsight. At that time there were a lot of difficulties that were more or less connected with the human equation. That is my impression at the time.

You say there has been a decided improvement.

Admiral HAYWARD. Well, there has been some improvement. We still have plenty of trouble, I can assure you of this, in not keeping permanency of personnel.

This is just something as you say, everybody wants to get ahead.

The CHAIRMAN. That is a human trait.

But are they affording more people the avenues of opportunity of going head, and of recognition?

Admiral HAYWARD. Yes, sir; we have. Take my case as an example. I was selected for admiral way ahead of my contemporaries.

The CHAIRMAN. Public opinion plays an important part when once aroused.

Admiral HAYWARD. Yes, sir. This is true.

Back in 1956, I was probably one of the few Democrats in Washington. They wouldn't give a Republican command of the *Franklin D. Roosevelt*, so they made me captain of that for several months, Mr. Chairman.

The CHAIRMAN. You talk about the Polaris. Can you discuss some aspects of it?

Admiral HAYWARD. Yes, sir.

It is our belief, of course, in solid propellants because we can't readily put liquid propellants in a submarine. And the Navy, during World War II, went down the line with the solid propellants. It has quick reaction time, can be maintained easier, and is just a better type of propellant for the IRBM than the liquid.

Liquid oxygen and JP–4 have plenty of problems, as well as some of the other exotic fuels that we have. Well, take this Polaris, which has a solid propellant; I feel it is the best missile in the country for this particular job.

The Polaris program is possible only because of the basic research we did on solid propellants. There are lots of problems in manufacturing large grains and casting these things. The metal parts, the warhead, and so on.

Four years ago we did not think it possible to do this. Today we do. And we have what I think is one of the outstanding missile programs in the country with the Polaris.

It worries me, however, because if we can do it, Mr. Khrushchev can do it also. And so we have to protect ourselves against this. And it worries me that everybody looks to the North Pole, when right 50 miles off our coast, why, every Russian submarine could be a potential missile-launching submarine. We have to have some defense against this.

So, it has brought some very hard decisions on the Navy, the decision not to build the new carrier, the decision to really try and do something in the antisubmarine business has been a hard one. We have been handicapped. Maybe we haven't been smart in the way we have tried to sell it to the public. We do not try to scare the people. From my point of view, this threat to the country is one of the greatest ones we have ever faced.

It has a lot of problems such as political ones. Suppose we do see these submarines out here. Suppose I track them all. What do I do about it? Do I sink them, or do I just tell everybody that there are 50 of them out there? Is there a magic number when I say "Well, look, we have a hundred out here now. What are you going to do about it?"

Maybe the day will come when we will be forced, as a country, to say that any submerged submarine within a certain radius of our homeland is a hostile act and we are going to sink them. I mean this might come.

But we have to first lick the problem technically of being able to locate, classify, and destroy these submarines if necessary. And it is a terrific problem. This is why Polaris—every day that I see Polaris in its success as it goes on, that worries me more.

The CHAIRMAN. Has the test been completed?

Admiral HAYWARD. We had a shot today. I hope it went well, I did not hear the results. We have been making flight tests and I think it would be very worthwhile if Admiral Raborn came up and had a closed session to brief you completely on it.

The CHAIRMAN. It is the firm judgment of Admiral Raborn and you and other men, other gentlemen, officers, that going ahead with the development of submarine types is advisable?

Admiral HAYWARD. Yes, sir.

Mr. FORD. Mr. Chairman, would you yield?

The CHAIRMAN. I would be glad to.

Mr. FORD. May I suggest rather than have Admiral Raborn come up here, it would be much better for us to go down there?

Admiral HAYWARD. That is right.

Mr. FORD. You would really see a first-class demonstration.

The CHAIRMAN. We will keep that in mind.

Can you give in open session any evidence as to the distance of the Polaris?

Admiral HAYWARD. Well, the requirement, yes, sir.

It is a 1,500 nautical mile intermediate range ballistics missile to be launched from a submerged submarine.

The CHAIRMAN. Probably can be extended too?

Admiral HAYWARD. Yes, sir.

The CHAIRMAN. We read a lot about satellites and that the satellites sent up, of course, were probably more or less experimental. But, friends of mine who are well versed and in whom I have confidence tell me that, while present satellites have no military significance, they could have a great future military significance; that satellites could be used and utilized for almost any purpose other than putting a human in them, if they wanted to achieve a specific purpose.

Would you care to comment on that?

Admiral HAYWARD. There are some things about satellites that people right at the moment, let us say—well, nobody has repealed Newton's law. And if you get up there on a satellite and try and drop something on the United States, if you throw it out, it is just part of the satellite.

In order to use a satellite to get something back to the earth, you have to propel it so that it has a zero angular momentum with the earth. And it is a pretty hard job to hit it. I mean hit where you want to.

However, I agree that even though at the moment all I can see from a military application is reconnaissance, communications, navigation, and intelligence purposes generally; you must remember when the airplane first flew they said this also about the airplane, that it was only going to be good for reconnaissance. So, we have to have imagination on it.

I am sure it will have military applications, but I cannot tell you in specific detail other than those I just named.

The CHAIRMAN. Is the mere weight of a satellite of importance in establishing a lead over a competitor?

Admiral HAYWARD. It is important in one basic assumption, which is the rocket thrust.

In other words, the amount of weight that one can get into orbit is a function of what we call the mass ratio. And that is E to a ratio of the velocity you need over the velocity of the exhaust gases. I won't get into technical details on it. But from this mass ratio one can calculate pretty much the thrust of the engines required to put something, a given load, into orbit. And on the basis of this, mere weight and weight along could indicate that the Russians have very fine rocket engines.

Now, of course, there are some factors—how many stages you have, and does he have the fourth stage hooked onto it—that would change it. But it is my belief that the Russians are ahead of us in rockets, particularly large thrust engines.

There is no question about it. I don't think any technical man would question that they are ahead of us. And I base this from more than just the weight of the satellite that they had, just from the rest of the intelligence we have also.

The CHAIRMAN. It is quite important that at no time are the Soviets in the position where they could hit us and we could not reach their targets; isn't that true?

Admiral HAYWARD. That is correct. This is very important.

This is why we feel in the Navy that in this war business—war is very complex now, Mr. Chairman; war covers a spectrum. It covers a spectrum all the way from the megawar or the all-out atomic exchange, down to what is going on in Indonesia and all the rest of them.

Now, this deterrent force we have, we have to have more than one

way of destroying the Soviet. If ever the Russian planner—and it is what the Russian planner thinks, not what we think—if he ever thinks he can destroy us without our destroying him, I am convinced he is going to do it.

Now, that means that this deterrent that we have cannot be the Strategic Air Command; it cannot be just Polaris; it cannot be just Atlas. You have to have a flexible posture so that you present to this man a practically impossible situation that no matter what he does in that megawar situation, he is going to be incinerated.

Now, this is the point—this is why we say Polaris is important. We don't expect to do away with the Strategic Air Command. You are going to have manned airplanes for years, the same way with the Atlas. But you are going to have a mixture and a flexible posture. And if you don't, then you always leave yourself open to having the Russians defeat you by being able to destroy a single force.

Now, I am convinced in the Vanguard situation that they knew everything we were doing. It was unclassified. They saw what we were doing. And they said, "Boys, here is a good chance." And they understood the psychological side of it. And they went down their alley.

And they will always go down the road that you neglect, do the things that you don't do; if they see a psychological advantage in it. And this is what they did there.

And if they could defeat our Strategic Air Command today—and if the Russian planner thought that, he would do it. But he can't. He has too many problems facing him.

He is ringed in by everybody. And he looks to the day when maybe he can.

So, we must have that flexible deterrent. If you just go down the all-out war business route, you are going to wake up some day to the fact that Africa, Asia, South America, and everything else is Communist, and you will be alone.

Then all you will is the choice of pulling the world down around your head, which you will never do.

The CHAIRMAN. If that ever happens, they could cause a lot of division among our people. You know, the primitive appeal—race, color, racial origin.

Admiral HAYWARD. Yes, sir.

The CHAIRMAN. But we won't go into that. I have thought of it many times. You talk about this liaison committee, on which I followed your testimony very closely.

It is hard to write into any bill language covering every possible detail, because no one knows what human action is necessary in administering a law or establishing an agency, an agency established as a result of a law. And in the world of today, at least in my mind, the military aspect has got to be given great emphasis. That doesn't mean control, however.

But the recognition of what, to me, seems to be inescapable is that in case of war we must look to you gentlemen to lead us, you gentlemen who wear the uniform. And I never forget it. The thought in my mind is that in the case of war these are the gentlemen we have got to look to, the leaders, to win the war.

The liaison committee, as I see it, without making a definite decision, would be able to bridge a lot of gaps between the civilian con-

trol—and would permit a lot of meetings where there could be quick agreements and might make more effective the operation of any agency we establish in connection with the importance of the military.

Admiral HAYWARD. I agree 100 percent with that, Mr. Chairman. I really think it is necessary and in the transition phase, this would work.

The CHAIRMAN. I will be frank. I hadn't thought of the significance of it until I listened to your testimony. It impressed me very, very much.

Are there any further questions?

Mr. Feldman.

Mr. FELDMAN. I only have one other question to ask, Admiral.

Did I understand you to say that you also believed in having such an agency responsible to a strong congressional committee or a joint congressional committee?

Admiral HAYWARD. Yes, sir.

Very definitely it has to have a strong congressional committee, and somebody that really follows the program and has a good staff. This is the Joint Committee on Atomic Energy. They have always lived in our pocket on this. This was a good idea and should be done in this business.

Mr. FELDMAN. Do you have any opinion as to whether or not the bill should have a provision making the Director a member of the Security Council or some such level?

Admiral HAYWARD. I answered Mr. Keating and I would repeat what I feel. If you don't have a Secretary of Science—and you say you put this legislation through now—I would recommend that in there you put him at a real high level, yes sir.

And then anything else that you ever did with tying all these technical agencies outside the Department of Defense together, then you would bring him into that. But at the moment, I would put him at a real high level, yes sir.

Mr. FELDMAN. Thank you.

The CHAIRMAN. There is just one feature of the bill that I would like to read. It is not a part of great importance. We pass on it. But I would like to get your views on this:

> Subject to the civil-service laws, to select, appoint, employ, and, subject to such regulations as the President may prescribe and without regard to the Classification Act of 1949, as amended (5 U S. C. 1072 et seq), and the Federal Employees Pay Act of 1945, as amended (5 U. S C 901 et seq.), fix and adjust, as nearly as consistent with the public interest and on the basis of equal pay for equal work at rates which are reasonably comparable with prevailing rates paid by non-Federal employers for similar work, compensation of such officers and employees as may be necessary to carry out the provisions of this Act.

I have no objection to that. But, on the other hand, I am wondering, from a relative point of view, how it might affect you, for example. Suppose the scientist in this Agency got the higher salary than the scientist in yours. What effect would it have?

Admiral HAYWARD. I have thought about this Mr. Chairman, having had to work under the Classification Act and having worked with the AEC. The contract operation of the Atomic Energy Commission gives you much more flexible use of your people. I feel, as a matter of fact, that it has certain advantages over the civil-service classifica-

tion setup. And if you know the scales as things exist today, at the lower rates in the GS–7, 8, 9, 10, they compared quite favorably with the outside.

It is after you get up to about GS–10 where you can't compete. You begin to lose your valuable people to industry then. This will have the effect of having the people that work in, for instance, the Naval Ordnance Laboratory; all of your good Government scientists who work under the Civil Service Act—these people could take them away from the civil-service side of the house. I am not so sure this is desirable.

The CHAIRMAN. Still, they are civil-service employees. This doesn't relate to the employees who are contractors.

Admiral HAYWARD. No. This is civil service.

The CHAIRMAN. What effect would it have on scientists associated with you?

Admiral HAYWARD. They would probably want to come to work for these people if they offered them more money, I am sure. This is what happens.

The CHAIRMAN. So that, if we keep that provision in there, it should go across the board, then?

Admiral HAYWARD. That is true.

The CHAIRMAN. Or strike that particular provision out, as much as I would dislike seeing that happen. If that stays in, we should go across the board and have it apply to all similar employees—officers, and employees that are in similar positions?

Admiral HAYWARD. That is correct. I have given a lot of thought to this and looked over past history.

The original Classification Act and the original blue-shirt employee, as you know, were not brought up. We have tried at several times as a result of the Riehlman report really to establish a scientific register under civil service, to no avail.

We have gotten some latitude. The Civil Service Commission has gone ahead, for instance; in the laboratories they would let us classify the jobs and say what we should pay for them. They did not send somebody in who was purely a personnel man and say this job should be in GS–12. They let us technical people classify what the job required.

This was quite an assistance to us. But my feeling would be that all of your Government laboratories—we have real good ones outside of the Navy, too, and the NACA—but if you wrote this provision in here, it should be written in the others. It should go across the board for the professional and scientific people in the Government. Otherwise, we are in trouble. We will lose our people. No question about it.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. One further question: Would you recommend, because of your experience with AEC, that corresponding liaison be set up with the AEC as we set up with the military?

Admiral HAYWARD. Yes, sir. In this manner: It is going to have to be, because some of the technical programs that this Agency will be engaged in will go across the AEC's research problems as much as ours. And this is one of the reasons for tying all of those technical agencies outside of the Department of Defense together.

Now, how you do this, or whether you just leave it up to the initiative of the Agency, whether you put it in the legislation, I would say no, I would not put it in the legislation with the AEC, because I feel that they will have to, by technical reasons, get together.

Mr. FELDMAN. We have had testimony from various witnesses to the effect that, in order to have a sustained program and one that is not necessarily immediate but will show results in the future, we would probably have to have the development of a nuclear-propulsion engine.

Admiral HAYWARD. That is correct.

Mr. FELDMAN. For that reason, it might be necessary to keep close liaison with AEC. And, if you spelled it out in the law, it might avoid any difficulties that could arise or that might possibly arise.

Admiral HAYWARD. Yes. Of course, you cannot cover all contingencies in the legislation, because we should have close relationships with the Bureau of Standards, the National Science Foundation, and so on. All of this—and the AEC, of course, is going ahead with nuclear propulsion. We will have it for rockets. This is not a hard problem. Admiral Rickover was not familiar with the program, but I am. It is easier to make a nuclear rocket than to make the hydrogen bomb. This is nothing too difficult.

Mr. FELDMAN. I realize, Admiral, that you cannot go on and spell out everything in the act, but there are some important areas. One is the military. The other is the Atomic Energy Commission.

Admiral HAYWARD. Well, all right; I hadn't thought of it, really, Mr. Feldman, along this line. I agree with you. You should cover it in some manner. I had thought more of the responsiveness to the military and the military liaison approach.

The CHAIRMAN. Apparently, on the Atomic Energy Committee, the drafters of this bill had something in mind, because they said the Atomic Energy Commission may authorize access to restricted data by the atomic-energy prospective contract licensee or prospective licensee of the Atomic Energy Commission, and so forth, and so on. So they recognized there was a relationship there. And whether that should be strengthened or not, I am not going to pass on now. So, apparently the drafters of the bill had something in mind.

Admiral HAYWARD. Yes, sir. You would have to cover that. Otherwise, it would not have any access.

The CHAIRMAN. Projecting my mind into the future, I am in quite general agreement with you. Sooner or later, there is going to be a Department of Science. I introduced a bill in the early part of the session and I made it "Department" because I recognized—well, you cannot force the "Department" upon the President. Congress could pass a law, but a wise Congress would not undertake to create an additional department unless there is responsiveness from the President.

Mr. FORD. May I ask a question there, Mr. Chairman?

The CHAIRMAN. Yes.

Mr. FORD. My views are apparently quite similar to the chairman's and the admiral's in reference to a Department of Science and a Cabinet officer. But didn't some representative group of scientists, national scientists association, or something, take a stand contrary to that in recent weeks?

Admiral HAYWARD. I don't know, Mr. Ford. But maybe they did. This is one thing about scientists; if you ever get agreement

among them you had better be suspicious. Because they very seldom agree. Look at the problem we are faced with today. Take Dr. Killian; I would be very interested to have a man of that stature at that level with his job defined. I mean, what are his responsibilities, you see.

Now he is a very powerful man today. And if he wants to stop something he can stop it. His particular position today—I mean he is ex officio.

The CHAIRMAN. It is determined by the will of the President?

Admiral HAYWARD. Yes, sir; that is correct. But what are his responsibilities?

The CHAIRMAN. I started to say that whoever drafted this bill apparently had in mind that there might be an extension, because section 8 says "For a period of three years after the effective date of this Act the agency with the concurrence of the head of the department"—there is a double negative there, but we can pass that over—"concerned and with the approval of the President"—the negative on the President—"the Commander in Chief, and the Chief Executive"—but that could be taken care of—"may transfer to itself any function" and so forth "of any such department or agency which relate primarily to the functions of the agency as set forth in this bill."

So I think that it is only a matter of time of applying the law of natural consequences when it is bound to develop into a department. And certainly it is going to get far broader than even this bill. Because you might have all these research activities scattered around where they are all related without connecting them together.

Any further questions?

Mr. O'BRIEN. I just wanted to make an observation.

I listened very carefully to the admiral and to the questions by Mr. Ford. I wanted to say, from what I have heard here in the last several days, that there is no indication that the military throttled science during that difficult period. And also all the evidence indicates to me that the military filled the vacuum to a great extent. And if it hadn't, what was a setback in the space field could have been a catastrophe.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. I think I have been asking almost every witness about this statement that has been attributed to Dr. Norris Bradbury. And I am sorry I overlooked directing the question to you. And apparently you were the person I very definitely should not have overlooked on that question.

Now, do I understand you to say that you agree with Dr. Bradbury's statement that it would be easier to make a nuclear propulsion engine, let's say, or reactor, that would move a spaceship, than it was to develop the hydrogen or the atomic bomb?

Admiral HAYWARD. Yes, sir.

Having been involved in both of those, why, I am sure it is easier, and having seen it also.

Mr. SISK. Let me ask you this: Are we progressing as we should? Are we doing the research and development work on that phase of space that is in line with the urgency?

Admiral HAYWARD. Yes, sir.

We have two very good projects, the Atomic Energy has; they have been responsive to our requirements on it.

I can go into the technical details of it. They are very well funded. We will have this, both in the straight rocket and probably in the ramjet.

Mr. Sisk. Thank you.

The Chairman. Thank you very much, Admiral.

For myself and the committee I express our sincere thanks to you.

The committee will go into executive session.

(Whereupon, at 4:50 o'clock, the committee went into executive session.)

ASTRONAUTICS AND SPACE EXPLORATION

MONDAY, APRIL 21, 1958

House of Representatives,
Select Committee on
Astronautics and Space Exploration,
Washington, D. C.

The committee met, at 10 a. m., pursuant to recess, in the caucus room, Old House Office Building, Hon. John W. McCormack (chairman), presiding.

Present: Representatives McCormack, Brooks, O'Brien, Metcalf, Natcher, Sisk, McDonough, Fulton, Keating, and Ford.

Present also: George J. Feldman, director and chief counsel.

The Chairman. The first witness today is Dr. John P. Hagen, Director of the Vanguard project of the Naval Research Laboratory.

We are very glad to have you with us today, Doctor. Have you a prepared statement?

STATEMENT OF DR. JOHN P. HAGEN,[9] DIRECTOR OF THE VANGUARD PROJECT, NAVAL RESEARCH LABORATORY

Dr. Hagen. No, sir; I have some notes I would like to speak from for the moment.

The Chairman. You may proceed.

Dr. Hagen. It is a great opportunity for me to be here to talk with the committee concerning this bill. I think the work of this select committee arises because the Russian satellite accomplishments brought into focus, and into the public eye, the Soviets' determined national effort and singleness of purpose not only to lead the world in the arts of weaponry, including ballistic missiles, but to base this effort on a broad foundation of education, research, and science and technology with the very obvious purpose of outstripping and perhaps dominating the world we know and the world that is to come. It is also obvious that the Russians have a plan for doing this and are dedicated to the task.

Now, this is their challenge to the free world. It is most gratifying to those who have directly shouldered some of the burden in meeting this challenge to have foremost representatives of the American people, such as this committee, apply their talents with vigor to the job of preparing enabling legislation.

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[9] Hagen, John P., astronomer; b, Amherst, N S., Can., July 31, 1908; s. John T. and Ella Bertha (Fisher) H.; B S., Boston U., 1929, M A, Wesleyan U., Middletown, Conn, 1931; postgrad. Yale, 1931–33; Ph. D., Georgetown U., 1949; m. Edith W. Sederling, Oct 12, 1935; children—J. Peter, E. Christopher. Research asso. Wesleyan U., 1931–35; supt. atmosphere and astrophysics div., development microwave radar, radio astronomer, mem. various eclipse expdns Naval Reserach Lab., Washington, 1935—Project dir Earth Satellite Project; mem. panel on radio astronomy Nat. Sci. Found; chmn. Asso. Univs. Steering Com.; lectr. Georgetown U. Recipient Presdl. Certificate of Merit. Fellow Inst. Radio Engrs., Am. Acad. Arts and Scts.; mem. Am. Astron Sec., Internat. Astron Union, Washington Acad. Seis, U. R. S. I. (sec. nat. com.), Sigma XI. Home: 3001 N. 2d St., Arlington, Va. Office: Naval Research Lab., Washington 25.

However, before we figuratively leap into space we must learn well the lessons of the past, carefully examine our present needs and bring our resources forward with purpose and utilize them wisely to their maximum potential.

We should revitalize the free spirit of inquiry which is so essential to our democratic way of life. We should investigate rather than fear the unknown and allow freer range of the long too-dormant pioneering spirit which made our country great. We should also assume a mature attitude toward failures and suggestions which are indeed the price and the reward involved in ventures of great risk.

Any of these ventures in space are going to be ventures of great risk because rockets are essentially risky. The history of Project Vanguard can teach us many lessons and we should learn them well lest history repeat itself in a more unfortunate way than the relatively harmless "beep" of the Soviet satellites.

First, let us establish what Vanguard is. Vanguard is a United States project in the International Geophysical Year; its prime purpose is scientific research. The job assigned was to establish at least one scientifically instrumented satellite during the International Geophysical Year and to prove that it was in an orbit. Now, the International Geophysical Year ends on December 31, 1958, so the guidelines given us were to do the job by that date.

To do the job we established an organization and planned a program including development of a suitable launching vehicle, since no existing vehicle met the specifications necessary to do the job when we started in the fall of 1955. Our early plan had been to build around the vehicles developed by the program to do the job. That is, to establish the satellite we planned a series of 13 to 15 vehicle firings; the first 7 or 9, dependent on progress, were to be used in the vehicle test program to develop the launcher itself; and the last 6 to contain scientific satellites.

The first three vehicle test firings, in May, August, and October 1957 were all extremely successful, but none were tests of the complete three-stage launching rocket. However, they did prove to us the soundness of our paper designs for the final complete vehicle. So in July of that year we decided that the remaining test vehicles would contain small satellites on the chance that one of the test vehicles would perform so well that the small ball would be pushed into orbit.

The first tests of the full three-stage launcher were made in December 1957 and February 1958. As is usually the case, and has in fact been the case in all missile development programs, these first test vehicles did not perform to final design objectives; but that was precisely why we fired them—to find out what else needed to be done.

On March 17, 1958, the untiring efforts of the Vanguard organization paid off. The small test satellite and the third-stage rocket are in a very high and stable orbit around the earth. The satellite will last for a long time, presently estimated at not less than 200 years. Most important, the very advanced design of the Vanguard rocket proved its capability. We have assigned the eight rockets we have left to the full-scale scientific satellite launching program. With these we will attempt to launch very sophisticated earth satellites to complete our obligation to the International Geophysical Year. Now, this is a tough business and the risks are great in terms of successes and failure. Both can still be expected.

As I have related, one might ask why are we so disturbed when Vanguard seems to be doing its assigned job in an orderly fashion. This is precisely the point.

The project represented a major national and international commitment which, in our opinion, was hampered in its early stages by these things:

(1) Too low a priority in the overall scheme, (2) virtually no industrial priority, (3) piecemeal funding which caused a lot of waste motion and cast a pall over the technical area, (4) too many administrative channels and levels to go through in order to get policy decisions and funds in the time limits with which we were dealing.

Now, in spite of these problems we have developed an organization and facilities which at present constitute the only complete package unit having the inbeing capability to conduct a satellite and space program. This includes: (1) The major functions of vehicle development and launching, (2) satellite design and scientific instrumentation, (3) radio tracking and scientific data telemetering, (4) orbit analysis and data reduction.

Earlier I mentioned that our chief international competitor obviously has a plan and is rapidly applying his energies to the fulfillment of that plan. I am sure he is not wasting any talent which can be used to achieve his goal, and that he has complete plans for full utilization of all of his talent for a long time to come.

Now, as an index of the state of our planning, project Vanguard has been given no go ahead of funds for a continuing program past the end of this year. We have forwarded very comprehensive plans to higher authority over the past 6 months, proposing scientific and military application of satellite units and space vehicles as the next logical steps beyond the present IGY Vanguard program.

The CHAIRMAN. What is that statement, Doctor?

Dr. HAGEN. We have forwarded many comprehensive plans to higher authorities over the past 6 months proposing scientific and military application of satellites and space vehicles as the next logical steps beyond the present IGY Vanguard program.

The lead times involved in this type of program are long and critical. Now, we feel strongly that the Vanguard organization is a national asset which should not be allowed to waste a day. It is highly complimentary to have the Air Force and the Army combining the Vanguard second and third stages with their large Thor and Jupiter first stages in spectacular moon probe vehicles, and indicating their need to use other Vanguard-developed hardware such as guidance equipment. However, to keep the country from slipping further behind in scientific and military applications we have asked higher authority for funds to go on to an advanced Vanguard program. The current lack of specific authorization of funds to continue our job, I have brought up to illustrate two points.

First, in considering the implications of the bill we are discussing today. The country needs a master plan for the conquest of space—a plan based on a sound scientific approach; providing adequate facilities, funds, and delegated authority to those entrusted with the job; and allowing them to proceed immediately with the first steps in the program. This master plan is essential before we can intelligently discuss an organization to carry it out.

The second point concerns a basic but related problem, the so-called shortage of scientists and engineers. I feel that this problem is somewhat exaggerated and is due in part to improper utilization of the talent presently available. As a part of this problem, there is the salary inequity which exists between scientists doing roughly the same work at gross differences in salary, with the civil service classified employee always at the bottom of the heap. For instance, the top five men on the Vanguard staff, all of whom bear extremely heavy responsibilities, are classified employees who average about $12,000 per year. Similar responsibilities in industries rate from 30 to 100 percent more in salary. Now, to maintain a balanced program the Government needs good scientists and good scientists should not be penalized earningwise, nor should anyone working in government.

That is the end of the statement I wish to make. From here on I am prepared to comment on specific questions about the proposed legislation and to answer any question as best I can.

The CHAIRMAN. Do you attach great importance to the necessity of an agency being established by law that will effectively administer this particular field?

Dr. HAGEN. Yes, sir; I do.

To return to that point about master planning, we should have a very comprehensive master plan and have it keyed in time so that we do have specific plans for achieving specific purposes by a specific date; and the only effective way to carry this plan out would be to have an organization such as the one proposed in this bill, charged with the responsibility and the authority to do the job.

The CHAIRMAN. Should the agency be on a high-level, decision-making basis?

Dr. HAGEN. It must be, for many reasons. My personal opinion there is that the agency should have a board, or a group of some sort, appointed by the President and responsible to him, for policy matters. The affairs of the group might be handled better and more efficiently if this policy-controlling board or group were not a part-time group but a small full-time board determining policy for the director, and if the program directors under the director executed this policy and were responsible to him for it. The board must be of such a high level that it is responsible directly to the executive.

The CHAIRMAN. Do you realize under the bill proposed that that is not provided for?

Dr. HAGEN. Yes, sir; I do.

The CHAIRMAN. There is a board of 17, which is the old board in theory, but in practice it continues as a part-time board, meeting at least four times a year, but instead of being above the director it is now below the director in this bill. Do you realize that?

Dr. HAGEN. Yes, I realize that.

I did not mean to imply that the board would be above the director. I felt that the director should be a member and perhaps the chairman of the board.

The CHAIRMAN. Do I take it, then, instead of the single director over the agency, you prefer a commission over the agency, say, five?

Dr. HAGEN. With the director being the executive director of the group.

The reason I believe this is the following: We are in for a long history of projects with tremendous public appeal. They are going to have a tremendous urgency about them, so that the plans and the carrying out of the board's policies are bound to be continuously changed; therefore the governing board must be always accessible to the director. It would seriously hamper his operations if he had to wait for periodic, say quarterly, meetings of the board in order to proceed with radical changes in his budget or his policy.

The CHAIRMAN. There are two ways of doing that. One, a director of the board along the lines you have said; the other is the commission and then, of course, the chairman of the commission would be in a comparable position to the chairman of the other commissions. Which method do you prefer between those two?

Dr. HAGEN. Sir, I did not quite understand the question.

The CHAIRMAN. I take it you do not like the idea of the 17-man board.

Dr. HAGEN. Yes.

The CHAIRMAN. Do you believe it should be a full time small board?

Dr. HAGEN. Yes, sir.

The CHAIRMAN. Always available and serving the Government in a full-time capacity?

Dr. HAGEN. Yes.

The CHAIRMAN. There are two ways you can make a full-time commission. Say it is five members, or three—I do not care which; I just wish to have your views—you could have a commission form of an agency, or an agency under the director of the board to advise them. Which would you prefer?

Dr. HAGEN. I would prefer the commission form although I must admit that the formation of a board under the director could possibly work as well. However, the stature of the individuals on a commission might be higher than the stature one could obtain in a board under a director.

The CHAIRMAN. Have you information that the Soviet Union is engaging in great activity in this particular field?

Dr. HAGEN. The information available to us—just the released information, the kind one obtains from newspaper and magazine reports, and from the statements of the Russians at meetings—clearly indicates that they have a determined program to advance beyond even the launching of satellites.

The CHAIRMAN. Doctor, could you elaborate on the nature of the advanced Vanguard program?

Dr. HAGEN. Yes, sir.

The present Vanguard vehicle has a capability of putting a satellite which weighs about 21 or so pounds into a stable orbit around the earth. The total weight that the present Vanguard can put in orbit is about 75 pounds. That is the 21-pound satellite and the 55-pound third stage rocket casing both go into orbit, giving about 75 pounds in orbit.

Now the advanced Vanguard is a modification of the present Vanguard, principally an improvement in the operation of the third and the last stage. This would actually make it possible to double the weight one can put into the scientific package and thereby greatly increase the amount of scientific work that can be done. The advanced

Vanguard would place a 40 to 50 pound satellite in orbit and, of course, the third-stage rocket as well, or a total of about 100 pounds.

The CHAIRMAN. Are there any tests proposed in the future?

Dr. HAGEN. Of this vehicle?

The CHAIRMAN. Yes.

Dr. HAGEN. We expect before the end of the Geophysical Year to run at least one test which will demonstrate this capability.

The CHAIRMAN. Do you have any idea as to how much weight it will be?

Dr. HAGEN. The weight we expect to put into the scientific package is about 40 pounds.

The CHAIRMAN. These rockets have many capabilities, have they not?

Dr. HAGEN. Yes, sir. The Vanguard vehicle was designed from scratch as a space vehicle. It has the most advanced design in all of its stages. It is then capable of being combined with other vehicles for space research by employing larger boosters. For example, replacing the Vanguard first stage with a larger first stage, one can think in terms of very much larger payloads or in terms of having the vehicle take the payload away from the earth and explore farther out into space.

The CHAIRMAN. Is there any proposal for trying to project one to the moon?

Dr. HAGEN. There is no authorization for the Vanguard organization to do this. The only authorization is one that was reported some several months ago when the Air Force had undertaken such a project employing some parts of the Vanguard vehicle. I do not feel free to discuss their method of doing it, however, in great detail.

The CHAIRMAN. Will you state why you feel that either a commission form of an agency, or this board, full-time board that you mentioned, is preferable to the organizational setup of the pending bill.

Dr. HAGEN. The principal reason is that this will be an extremely busy group, that a great deal of their attention will be required. The full-time board, then, would devote itself entirely to this aspect of the work. Their life's work would be to see that our program in space research and exploration would be well thought out and well conducted.

Another point is that the full-time board would not have the same conflicting interest that the parttime board, I think, is bound to have. It is difficult to have a group so chosen that they can unselfishly serve two masters.

The CHAIRMAN. Do I also infer it to be your opinion that this gives a better opportunity for the assumption of responsibility and for decisions to be carried out quickly and effectively?

Dr. HAGEN. That is basic.

The CHAIRMAN. The question of responsibility is the uppermost question in anyone's mind.

Dr. HAGEN. Yes. This group will bear a heavy responsibility and one of the things that I believe is taken care of in the bill is that the necessary authority and ability for direct action be given to both the director and the group.

The CHAIRMAN. Would it be fair to say that once the agency is established it probably will be absorbed with activities within the Government in the future?

Dr. HAGEN. Yes, sir. In order for this group to function and to make the immediate progress that it must make, there certainly would have to be an absorption of some existing functions.

The CHAIRMAN. In other words, we cannot have research activities distributed among several departments and agencies. Sooner or later we have to come to a coordination, or call it centralization; is that right?

Dr. HAGEN. To a certain extent that is right. I do, however, believe that the other agencies or departments must carry on research to a point in order to support the basic research, to support their peculiar activities, and that the research carried on in other activities might be very broad and not precisely directed.

The CHAIRMAN. Of course, that can be worked out. You mean the Defense Department?

Dr. HAGEN. For example, the Defense Department.

The CHAIRMAN. Those matters can be worked out by understanding minds cooperating as such.

Have you an opinion of the level such an agency; should it be on the level of the National Security Council in relation to the President?

Dr. HAGEN. I would hope that the agency would be of such a level that the director would report to the President through the Security Council.

The CHAIRMAN. Or if there is a commission, the commission?

Dr. HAGEN. Yes, the director representing the commission, or the chairman of the commission.

The CHAIRMAN. In connection with this field—I call it field for broad purposes of description—and projecting your mind as to the importance in the future, is it of sufficient importance that it should have quick access to the Commander in Chief?

Dr. HAGEN. Yes, sir; I certainly believe that.

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. Doctor, in reference to the board which the chairman has been inquiring about, if you have a full-time board, meeting at all times, what then is the need for having a director?

Dr. HAGEN. The director would bring together the divergent thoughts of the board when he had gained an agreement on a policy and direction for action; he would then act as the executive agent in carrying out this action.

Mr. BROOKS. You would have purely an advisory board, and the director would try to get their composite views. Then after he had gotten them he would go ahead and act as a director?

Dr. HAGEN. That is a method of operation.

On the other hand, I see no reason why the director could not assign certain areas of policy study and planning to the members of the board.

Mr. BROOKS. In other words, the director would employ members of the board?

Dr. HAGEN. You might state it that way, yes.

Mr. BROOKS. This is what I am concerned with.

If you are going to have a board of 17 members meeting at all times and that board selects a director and then the director has the authority to employ members of the board, are you going to have a setup that will be workable?

Dr. HAGEN. No, sir. I was talking about a different thing when I answered your question. I was thinking in terms of the smaller, full-time group. I believe your question concerns the board as it is proposed in the bill.

Mr. BROOKS. Now, a smaller group would be more like a commission or council of five people.

Dr. HAGEN. Yes, sir.

Mr. BROOKS. They would select a sitting manager, that sort of setup.

Dr. HAGEN. Or, conversely, the director and chairman of this group would be selected by the executive office of the President.

Mr. BROOKS. The director and chairman of the board would be selected by the President rather than by the board?

Dr. HAGEN. Yes, sir.

Mr. BROOKS. Then the director would have the authority to employ any of the members of the board? The board would establish its policy?

Dr. HAGEN. The board, as a group, would establish the policy for the agency.

Mr. BROOKS. But would have no executive authority?

Dr. HAGEN. Except as that executive authority in areas is delegated to it by the chairman. The chairman of the board would have executive authority to carry out the policies of the board.

Mr. BROOKS. Then what would the director have?

Dr. HAGEN. I think of the director as the chairman of the group.

Mr. BROOKS. The chairman of the board would be the executive director?

Dr. HAGEN. Yes, sir.

Mr. BROOKS. He would be chairman of the board legislatively and executive director in addition; he could employ any members of the board?

There, though, are you not having a situation of divided responsibility in the executive branch in the execution of the program?

Dr. HAGEN. I did not believe so. I felt that the principal function of those on the board is to establish policy for the group. I did not believe that the assignment to them of other functions in the planning of the agency would interfere with them as a policymaking group, sir.

Mr. BROOKS. I am not trying to confuse you, but it would seem to me with a small group to legislate, so to speak, on the objectives of the program and then having the director as chairman to carry out that program, and authority to employ the others, you are combining the whole thing and you might as well set it up as a board to hold both legislative and executive responsibilities. What do you think of that?

Dr. HAGEN. The point that I was really getting at there was this—and this was in answer to an earlier question—that I believed the members of the Board should not be responsible to the Director for determining policy, but to the higher authority who appointed them.

Mr. BROOKS. The President?

Dr. HAGEN. The President, let us say, and that they as a group determine policy.

Now, the other functions that the Board members might perform in carrying out the planning of the Agency, I would believe, should not interfere with their stature in determining policy.

Mr. BROOKS. They would still be responsible to the President for the proper performance of these other duties, too; would they not?

Dr. HAGEN. Perhaps I have confused the issue. I did not believe that it was necessary that they do so.

Mr. BROOKS. Well, I am not going to pursue that. I just wanted to get your ideas on it. But I did want to ask you about this Vanguard organization.

You disturb me a good deal when you say unless some action is taken the Vanguard organization will go to pieces at the end of this year.

Dr. HAGEN. That is true. We have essentially completed a phase of the job on which we are working. In this work a long lead time is required to get experiments prepared and vehicles designed and built. We are now essentially completing the building of the vehicle and have before us one phase—to attempt to launch the remaining vehicles successfully. We are, in other words, phasing out certain phases of our work.

Mr. BROOKS. You are completing your mission successfully. You need the go sign at once, then?

Dr. HAGEN. Yes, sir.

Mr. BROOKS. If you get the green light right away, will that be ample time to continue your program, or even then will there be an intermission?

Dr. HAGEN. Even then there will be a slight hiatus, but it is not too late.

Mr. BROOKS. So the failure to act today is already creating some delay in your program?

Dr. HAGEN. That is correct.

Mr. BROOKS. I want to say to you today, sir, that I think you ought to be given the green light, that there should not be any interruptions in your program in the development of the satellite.

Now, what about the Jupiter-C? Is it in the same status as the Navy program?

Dr. HAGEN. The Jupiter-C is in a slightly different status. It is based on an assisting military vehicle, the Redstone. It was brought into this program as a backup vehicle when we became concerned about our abilities to match the performance of the Russians after their October and November firings. This was an insurance program.

Mr. BROOKS. I think we made a serious mistake in jumping from the Jupiter-C program over into the Vanguard program suddenly in 1956. Since that has been done you have done a successful job, but it was very doubtful to me at times that you would be successful.

Since you have done it, we would be making a serious mistake now in letting your program lapse or even subside for a while rather than be pushed ahead. Do you not agree with that?

Dr. HAGEN. I certainly do.

Mr. BROOKS. What authority do you need to go ahead with that program?

Dr. HAGEN. The authority would have to come from the office which has recently been set up in the Department of Defense.

Mr. BROOKS. From Mr. McElroy, the Secretary of Defense?

Dr. HAGEN. Or Mr. Johnson's group in the ARPA.

Mr. BROOKS. The new Agency?

Dr. HAGEN. Yes, sir.

Mr. BROOKS. I, for one, hope the new Agency does not delay in giving you the authority.

Now, you say the maximum weight you can carry, usable weight, would be 40 pounds in the Vanguard? Now, does not the Vanguard have greater possibilities than the lifting of 40 pounds of usable weight?

Dr. HAGEN. Not in its present form. It is part of our planning to make this Vanguard vehicle capable of putting even larger satellites in stable orbits. To do that, however, we would have to modify the first stage. We have considered this and we know how to modify the first stage to put a few hundred pounds into an orbit.

Mr. BROOKS. That was the real reason for the switchover to Vanguard, because we thought it had greater possibilities of developing a capability of carrying a much heavier satellite; that was it, was it not?

Dr. HAGEN. Yes, sir.

Mr. BROOKS. And will we be able to develop that Vanguard to the point where it will carry a missile of a thousand to 2,000 pounds in usable weight?

Dr. HAGEN. Yes. What is required is an orderly progression to take the first step, the improved Vanguard I mentioned earlier, which will bring us up to 40 pounds, and then to replace the present booster, which uses the GE engine, with a larger booster. If this were done we could put a satellite that weighs anywhere between two or three hundred and a thousand pounds in an orbit around the earth.

Mr. BROOKS. When are we going to start work on a missile that will carry a satellite of 2,000 pounds so as to offset the science and the effect of the Soviet missile?

Dr. HAGEN. There are presently in existence plans which I should not discuss in detail in an open meeting, to make even larger satellites.

I would like, however, at this time, to make a short point and that is this: The weight of the satellite is not always the important number. The important thing is the quality of the experiments and the weight and perfection of miniaturization of your equipment.

I sincerely believe that we have techniques in this country, and are using them in the Vanguard effort, which will make it possible for us to put much more equipment in a package of a given weight than our competitor. So, again, it is not really the total weight that counts, but the number and quality of experiments, and the degree to which you have miniaturized your electronics.

Mr. BROOKS. But the ultimate is to increase the size of your satellite and to increase the ability of the satellite to carry, we will say, the weight of a man?

Dr. HAGEN. Yes, it is.

This brings out another point that I would like to lay a little emphasis on. All of us believe that the ultimate goal here is to put a man in a space vehicle. What that man will do when he gets there is something that needs to be determined on the plane of a policy and a plan.

However, the important thing is this: We should not allow our feeling of competition with our present adversaries to make us lose sight of our belief in the dignity of the human soul, in the rights of individuals. We should, therefore, never subject an individual to almost certain destruction when we have the capability of putting into satellites experiments which will determine the exact nature of outer

space—the effects of the primary cosmic rays, for example, and the effects of extreme radiation upon the human body—and when we can also experiment in the laboratory to determine the mental and physical effect of weightlessness for a certain amount of time on the human body. We should do all of these things before we put a man into a vehicle and shoot him off into space.

Mr. BROOKS. I think you have made a splendid statement in that respect. I agree with you fully.

Now, out of your 13 to 15 vehicles, how many have you fired thus far?

Dr. HAGEN. I did not bring the count with me. There have been test vehicles through No. TV–4, which means that there have been 6 test vehicles fired, the last 1 having in its nose the small test satellite that is now in orbit. We have ahead of us 8 vehicles capable of putting up the large IGY spheres.

Mr. BROOKS. When are you going to fire the next one?

Dr. HAGEN. The newspapers, I understand, are reporting that it will be Thursday of this week.

Mr. BROOKS. You have not decided it, have you?

Dr. HAGEN. No, sir; I have not, but I will state that it is going to be very soon.

The CHAIRMAN. Do you challenge the probable accuracy of the newspapers?

Dr. HAGEN. I think we can just wait and see.

The CHAIRMAN. You said in the near future?

Dr. HAGEN. In the very near future.

The CHAIRMAN. That does not mean weeks?

Dr. HAGEN. That does not mean weeks.

Mr. BROOKS. So we can expect some action down there at Banana River soon?

Dr. HAGEN. Yes, sir.

Mr. BROOKS. Yesterday in a newspaper interview you referred to the fact that the Vanguard satellite would probably be up 200 years before it comes down. Is that your mature judgment?

Dr. HAGEN. It is. It took us a long time to arrive at that conclusion, because the orbit is so stable that the changes in it are hard to measure. The mere fact that the changes are hard to measure indicates the lifetime is going to be long. In the month the satellite has been in orbit we have closely observed the rates and the period at three well spaced times, and from that have been able to draw a firm conclusion that the lifetime will be at least 200 years.

Mr. BROOKS. Is that because of the peculiar ellipse that orbit has? Is that one of the reasons?

Dr. HAGEN. The reason for the long lifetime is that the perigee, or least distance from the surface of the earth, is 400 miles. This is, the important number in any satellite orbit, because the thing that makes the orbit decay is the drag in the residual atmosphere. Now, the density of the atmosphere decreases rapidly as you go up from the earth. So the larger you can make the perigee distance, the longer the lifetime is going to be.

Mr. BROOKS. And the perigee is not changing a great deal, then?

Dr. HAGEN. It is staying very, very constant.

Mr. BROOKS. Now, what are we going to do with a satellite up there 100 years or 200 years from now?

Dr. HAGEN. I like to think that our grandchildren and our grandchildren's children are still going to make use of that satellite. It has in it a small radio station operated by solar cells; that is, the electricity is generated in the satellite by the sunshine.

As times goes on we will use the perturbations in the orbit of this satellite for determining the shape and size of the earth and for measurements on the density of atmosphere and the way that density varies with the activity of the sun. Our descendants will be even more adept than we are in observing and in interpreting these things, so it is hopeful that this will be of use to mankind.

Mr. BROOKS. You do not have any serious thought that that radio is going to be operating 200 years from now, do you?

Dr. HAGEN. I would be very hesitant to make a prediction as to how long that radio will operate, but I believe it will operate for a very long time.

Mr. BROOKS. Do you think our descendants will be blessing you rather than abusing you for putting a satellite up there for 200 years?

Dr. HAGEN. Provided they are not members of the Federal Communications Commission and concerned about the radiation coming down.

Mr. BROOKS. Are we not making some effort, though, to be able to bring those things down so that satellites won't be running around this earth here for 200 years uncontrolled and perhaps a real menace to us?

Dr. HAGEN. It does have great significance to those of us in the program. Space will be filled with deadened, useless satellites after a while. This is going to constitute a menace in more ways than one. We are considering ways and means of bringing these things down. Now, that is not an easy job. You have something moving at 5 miles a second, several hundred miles from you, and you must shoot up a missile to destroy it.

However, you do not bring it down. Even though you break it into small pieces, these small pieces will still circle the earth in orbits. They will experience a greater net drag effect and in time will be cleaned out, but the point is that once you put something in orbit around the earth it is a most difficult thing to remove it.

Mr. BROOKS. It would seem to me, then, that that is one serious concern the world should have, that no nation place uselessly in orbit satellites and parts of satellites to run around this world for several hundred years which will be a constant and serious menace to anyone who lives on earth.

Dr. HAGEN. Yes, sir; that is true. I believe there should soon be set up an international commission, or at least there should be a conference on an international basis to establish, by treaty if necessary, limitations on what one can put out into space and what kind of radio transmitters one can put in these things.

Mr. BROOKS. That is an almost immediate need, is it not, because every time a nation puts up a satellite that menace increases; is that not true?

Dr. HAGEN. That is true. The number of satellites that can possibly be in the air in another year or two is counted far beyond the fingers on your two hands.

Mr. BROOKS. That is what I am afraid of.

The CHAIRMAN. Mr. Metcalf.

Mr. METCALF. Dr. Hagen, in your response to some of the questions the chairman was asking about the organization of the Commission, a Director, or these various setups that we can have, I think you made it very clear how in your opinion this should be organized.

But I do not believe you commented on one of the proposals that we have a Secretary of Science and Research in the President's Cabinet. I wonder if you will comment on that.

Dr. HAGEN. Sir, I think it would be a very fine thing for science in this country and, therefore, for the country as a whole, to take such a step.

We are living in a technological age. Our very existence depends upon our continued advance in science and technology. I am sure it will become more so as time goes on. Just as you now have a Secretary of Commerce, I do believe that we would all benefit by giving science the stature of having a Department of Science.

Mr. METCALF. You made made some comment about the fact you do not think all the research programs should be removed from the various agencies, but one of the proposals we have is that the Secretary of Science and Research take Commerce, Weather Bureau, Agriculture, the testing for better production of seed grains, all of these things. If the Department of Science and Research is created, would you leave those agencies down there?

Dr. HAGEN. On each one you would have to make an individual decision, but in each one I think you would have to take the bigger pieces.

The point I tried to make earlier is this: that in any one of the other departments, for example the Defense Department, in order that the Department not become sterile in the field, there must be within it a group concerned with basic science and scientific research. The Department, however, could call on other agencies.

Mr. METCALF. And the application of all research to various agencies such as the Department of Agriculture, which would have to have some research men in the Department to make application of the basic research in the other agencies?

Dr. HAGEN. Yes, sir; that is correct.

Mr. METCALF. You mentioned that there was clear evidence of a determined Soviet program on space beyond satellites.

I wonder if you can expand both on the clear evidence and the kind of program for space beyond satellites?

Dr. HAGEN. I will restrict my expansion to what I have read in the newspapers and have gotten from talking with Soviet scientists, and I think even that brings clear evidence.

At the time of the IGY meetings here in Washington last September, the Russians sent over their top rocket and satellite people. They mixed with the representatives of the other countries who were there, in particular the people who were working on this thing in the United States, and talked rather freely with them.

At that time it was made clear to us by the leader of the group that the Soviet program was a strong program; that it had a lot of backing at home, and that it was then their intention to attempt to launch satellites at the rate of one per month. Now, if they have carried through with their intentions, they have not been successful in putting satellites into obit at that rate. But the indications are certainly that

they had the intention, and they most probably have tried. They have within the Soviet Union, and I do not remember the exact name of the organization, a commission on astronautics which is set up to guide work of this kind in terms of long-range planning and specific guidance on the immediate program. In this respect they are ahead of us in the planning. This is the kind of thing to which I referred.

Mr. METCALF. In response to one of the questions directed to you by the gentleman from Louisiana, you said the ultimate goal is to put a man in a space vehicle. Is that what you mean by the Soviet program for space beyond the satellite?

Dr. HAGEN. Yes. And this is one specific comment I would like to make about the bill before us: I believe that in time one of the principal things that will be done in space is exploration. Now, exploration is not specifically assigned as one of the responsibilities of the agency in the bill. I think none of us could today be specific about the precise kind of exploration that would be done, or the possible benefits that would come. We do know that we are going where man has never been before, and it would be foolhardy to predict the exact benefits that will be derived. You may be sure, however, that there will be benefits.

Now, in the beginning this exploration can and must be done by unmanned instrumented vehicles. But the time will come when we will want the intelligence of a human being in place to direct whatever is being done.

The CHAIRMAN. What about this language:

> * * * solution of, problems of flight within and outside the earth's atmosphere and that provision also be made for the development, testing, and operation for research purposes of aircraft, missiles, satellites, and other space vehicles, manned and unmanned, together with associated equipment and devices.

Would you say that that language covers exploration in space?

Dr. HAGEN. I did not believe it did. Perhaps I did not read it carefully. The interpretation I placed on it was that the bill would authorize the development and design of a vehicle to do this kind of thing, but not specifically the carrying out of the exploration. This is the point I want to make.

Mr. METCALF. As I understand your testimony, you are convinced the Russians have a master plan for exploration into space beyond putting satellites into orbit, and it is up to us to get a commission or some govermental agency together to put together a master plan for us to get ahead of them in space exploration.

Dr. HAGEN. Yes, to give considered judgment as to how far we should go in this area and then to formulate a good constructive plan for achieving the goal that is determined.

Mr. METCALF. I gather from your testimony, on the basis of the priorities you were given, the appropriations you were given, and the limitations that were put upon you in the Vanguard project, we have no apologies to make for the success of that project.

Dr. HAGEN. Yes. I brought this matter up to point out that if we do go into a program of this sort it is bound to have the same appeal to the country as a whole as the satellite program had. And if this is so, we should benefit by the mistakes made in the satellite program, should recognize that aspect of the program and recognize that therefore it must have adequate funding and adequate priorities in the very beginning.

Mr. METCALF. Had there been such an agency as is proposed in the several pieces of legislation, you would have had the flexibility and the authority to go to some secretary or director and take into account the new urgency that occurred last October?

Dr. HAGEN. Yes, sir. That being so, there would have been recognition at the time of the tremendous public appeal of a program of this sort. The psychological impact of this was not fully understood at the time we were planning our program.

Mr. METCALF. Thank you, Mr. Chairman.

The CHAIRMAN. Doctor, will you submit to the committee your suggestions as to how you think the bill can be improved?

Dr. HAGEN. Yes, sir.

I have just 2 or 3 in the main. The aim back of the bill and the method in which it proposes to achieve that aim, I think, is very fine.

There is, however, the point I made earlier about not identifying exploration specifically as an objective. This, I believe, is a point which would strengthen the wording in the bill.

On page 4 there is a point where I feel I might ask a question and perhaps offer an opinion. At this point it is stated in the bill:

> The Chairman of the Board shall be designated from time to time by the President from among the members appointed under subsection (a) (2) of this section * * *

The Chairman of the Board then is limited to those members of the proposed Board who come from outside the Government. Now, as a long-time Government employee, I do not see the reason for this restriction. You will find in the Government very conscientious and capable people who are not only scientists, but who have executive ability, and I believe that they could be among the possible choices for Chairman of the Board without being concerned about a conflict of interest. I would, therefore, recommend that this restriction on the choice of Chairman of the Board not be in the bill.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Doctor, do you agree our country is still ahead of the Soviet Union both theoretically and experimentally in most scientific and technological fields?

Dr. HAGEN. No, sir; I do not think that I could make that statement. I believe we are ahead of them in a great many things, but in other areas they are ahead of us.

In the areas of instrumentation—and perhaps you are referring to the instrumentation of such things as satellites—the devising of a sophisticated scientific experiment and the preparation of this experiment for placing in a thing like a satellite, I believe we are ahead of them. On the other hand, they are certainly ahead of us, as was indicated quite clearly, in the capability of putting X number of pounds into a satellite orbit.

Mr. NATCHER. I understand from your testimony the average salary of the top 5 scientists is $12,000. Do I understand that correctly?

Dr. HAGEN. Yes, sir. The average salary of the 5 top individuals working for me in Vanguard is $12,000.

Mr. NATCHER. I certainly agree with you, Doctor, that salary is too low. One of the things that we should do in this country, I believe, is to recognize our scientists from the standpoint of paying them what they are entitled to.

In the Soviet Union today, scientists are looked up to as well as generals and admirals. They occupy a position of great importance at the present time. Is that your information?

Dr. HAGEN. Yes, sir; this is the information that I have from what I think are fairly authoritative sources. At the present time in Russia a successful and producing scientist has a choice position. He is rewarded not only by respect and the benefits which are given to one's self, but he is also rewarded in a salary that is commensurate.

Mr. NATCHER. Doctor, a scientist employed by the Federal Government today is working under extreme handicaps and pressure. You agree on that?

Dr. HAGEN. I think a great many are, yes.

Mr. NATCHER. In fact, isn't it just a little harder at the present time to work with the Federal Government than it would be to work for some company in private enterprise, with the pressure on as it is?

Dr. HAGEN. Well, it would be difficult to substantiate that statement in detail. I think on the average, if you take people as a group, this might be true, but I am sure someone could bring up the exception which breaks the rule.

Mr. NATCHER. As I understand it, the proposal before the committee calls for the space board not to exceed 17 members. In your opinion, this particular number is too large? Is that correct?

Dr. HAGEN. I believe a smaller number would be a more manageable group, and agreement could be obtained on matters of policy much more efficiently and effectively.

Mr. NATCHER. Assuming the number is changed to 5, how should the 5 be allocated as far as the agencies of our Government are concerned, the military services, and scientists? What, in your opinion, should be the allocation, assuming the number is five?

Dr. HAGEN. I hadn't thought in terms of allocating them by position in Government. I would think the individuals would be chosen for their ability and their experience in the field, rather than to be chosen as representing some agency of Government or industry.

Mr. NATCHER. Assuming the number is 5, should the military services have 1 member or more than 1 member, Doctor?

Dr. HAGEN. Well, I would certainly think, and hope, that at least one of the members would come out of the military departments. The reason for this is that there is bound, always, to be a relationship between the functions of this Agency and of the Department of Defense. There needs to be a cross-organization, and a common use of tools and of equipment. On the other hand, a great many of the advances that I am sure will come out of this effort will have military use or value, or can be slanted toward the better defense of the country.

At the same time, the military will have hardware which will be of use to this Agency. Therefore, there will be a close relationship between the Agency and the military. I would think it would be highly advantageous to have in the Board people drawn from the military side, from the Department of Defense, who are aware of the capabilities and potentialities of groups in the Department.

Mr. NATCHER. Doctor, in your opinion, does science deserve a place in the Cabinet at the present time?

Dr. HAGEN. My earlier answer to that was "Yes."

Mr. NATCHER. How long will it be, Doctor, before we can take one of our satellites out of orbit, or can we do it today?

Dr. HAGEN. You mean to remove it. We cannot do it today. I think if one were—let me put it on a personal basis, it is easier then. If I were assigned the task and given the necessary tools to try to do this, I would expect it to take something on the order of a couple of years, at least, to be at the point where I would make the first test of the technique.

Mr. NATCHER. Thank you, Mr. Chairman.

Mr. BROOKS (presiding). Mr. Sisk.

Mr. SISK. Doctor, a little while ago you discussed the fact that we might ultimately have quite a flock of satellites in orbit. There was some discussion of the menace involved. From what I have been told, there is quite a bit of space out there, quite a bit of room involved.

To what extent do you consider even a substantial number to be a menace. What do you mean? A menace to those of us here on earth or a menace to later space travel? Would you interpret it a little further, if you are in a position to do so at this time?

Dr. HAGEN. I don't in any way consider it a menace to future space travel. As you say, space is a tremendously big place, and the chance of colliding with an odd satellite in the future is bound to be very, very small. But I think the astronomers should be concerned about the corruption of space with these things. Astronomers are tidy people and they like to keep track of everything in space. It is going to present a great problem to know what each of these things is, especially those large enough to register on their photographic plates.

The principal concern I would have, however, has to do with the defense of the country. You can only guess that as time goes on, we will be more and more concerned about the possibility of missiles coming from somewhere on the other side of one ocean or another. We will have to do the same kind of warning devices that we have today for planes, to identify these things as they come along. The distinction, for a quick look, between a satellite going overhead or coming at you, and a missile or a meteor is not very great. It will take a careful look to determine in a very short time whether the object you see coming is some old satellite, an ICBM coming from across the water, or a stray meteor coming into the earth. However, we are going to have to do this. Filling the air with a great many dead satellite bodies is simply going to make that task extremely difficult.

Mr. SISK. Any opposing nation or any nation with whom we might be at war, of course, would be confronted with exactly the same situation, because certainly they will have instrumentation, and will have their radarscopes, and so on, too.

Dr. HAGEN. Yes.

Mr. SISK. In summation, then, the menace which you discussed with the gentleman from Louisiana has to do with the potential threat to peace?

Would that be a proper summation of it?

Dr. HAGEN. I think that is a proper statement, properly interpreted. It has to do with the national defense, and the desire to keep the situation as cleanly defined as it can be, so that there can be no accidental starting of a war, for example, by an improper interpretation of the meaning of something you see coming over.

Mr. SISK. Doctor, I understood you to say earlier that you did not feel we were making proper utilization of our scientific and engineering knowledge in this country.

In what way do you see application in the proposed legislation to improve that ultilization?

Dr. HAGEN. Among the great improvements that could come about could be the consolidation of the effort under one agency or at least consolidation of the planning of the effort within an agency so there can be more effective use of manpower. We would then get away to some extent, I trust, from the situation where we have groups of people with certain capabilities built up here and there throughout the country and being held against the chance that a piece of work or a contract were common to the group. The number of scientists and engineers that we in this country are holding in that state, I am sure, is a large number, a fair percentage of the total of top capability.

Mr. SISK. You do not anticipate a consolidation of the various teams of scientists under a program of this kind, do you?

Dr. HAGEN. No, I meant more the consolidation of the purposes, so that plans would be clearly made for carrying the work forward and the various groups could then be intelligently brought together and applied to the different parts of the plan. To a large extent today we are operating without that kind of plan. It is a matter of improvement in the use of people through planning their movements rather than having each go off in his own direction, hoping that altogether eventually we will bring forth the thing desired.

Mr. SISK. You have no particular criticism, or maybe you do, as to the divisions of these various teams. For example, a team operating at the Redstone Arsenal, your own particular team, a team in Los Alamos or somewhere else. Do you feel that tends to expedite the work, or do you feel that that division possibly breeds delay?

Dr. HAGEN. The answer depends upon the answer to another question, and that is: What degree of planning has been done to begin with? Certainly if the planning is well done, the distribution of the effort in 2 , 3, or a half-dozen different places will not adversely affect the efficiency of carrying out the plan. The plan itself is the thing which determines the efficiency.

Mr. SISK. So that this high-level agency, then, will actually become a coordinating group, to coordinate the work of the various teams; is that a proper analysis of it?

Dr. HAGEN. I would like to believe that, to a degree, this is the way it would operate. However, the Agency should have its own laboratories, field stations, and launching facilities. It should be possible for it to be a self-contained agency. However, in order to prosecute the work in the most efficient manner today, they would have to go to other assisting agencies to carry out some of the projects.

Mr. SISK. Doctor, you made the statement a little while ago that Russia had been able to develop an engine with sufficient thrust to project a much larger payload, object, or otherwise, into space. You indicate they are well ahead of us in that particular feature. On the other hand, you felt when it came to instrumentation possibly we were ahead of the field.

Why would you say that? How do you know that? Are we simply alibiing a little bit? In this, I don't mean to be critical about you. I recall last fall, immediately after the Russians launched the sputnik, when I was asked questions in certain meetings, I said, "Yes, we will have a satellite in space shortly, and I am sure ours will be better instrumented."

When I sat down and analyzed it, I think I was simply alibiing. Are you prepared in an open meeting to say on what you base your statement?

Dr. HAGEN. Yes. I am not afraid to state on what I base the statement. It is built upon something that is intangible—upon my observation of the Russian scientists, while they were here in this country, upon watching them to see what they most deeply admired, in what things they showed the greatest interest. They most admired and showed the greatest interest in the experiments we were preparing and the highly sophisticated miniaturization processes that we were using to put a lot of experiment into small space. This brought out from them a great interest. I believe you can take this as an indicator that they were seeing something they themselves didn't have.

Mr. SISK. One other thing that has been of some concern to me, Doctor, has been a position of follow-the-leader we have permitted ourselves to reach. Are we in a situation today, in this space and satellite program, and, of course, it has its military application in the ICBM and IRBM, of depending almost wholly upon political initiative alone?

Why are we in a position today where we are so dependent upon political forces, upon the governmental end of it, let's say, to move ahead? I am thinking now of how we developed the airplane, and how we developed many other things that put us ahead in the world. Why do we find ourselves in this position today?

Dr. HAGEN. That is an awfully difficult question to answer. I think historians and philosophers many years from now will debate the point. But for many reasons, we in this country were somewhat adverse toward discussing space travel or taking it seriously. It was considered to be comic book material.

We didn't appreciate its full impact. The real answer, I think, to your question goes back to the matter that I mentioned before, of a proper plan. I believe we will get away from the position of following the leader—and there is a strong tendency to do this—wherein if the other fellow makes an advance you try quickly to equal or better it.

For our own good it would be much better to let the other fellow go his own way and for us to recognize that this space age has opened a new frontier and to plan what we, as a nation, want to do, and then set about doing it and not worry about when the other fellow makes his steps. If we make a real plan and make it in such a way that one step logically leads to another, we will get there in the end much quicker.

Mr. SISK. I am happy to hear you say it. That is the thing which is becoming of increasing concern to me, as I listen to witness after witness here, and we read newspaper articles. Seemingly, today, we do things simply because Russia or some other power has done

them. I think some of us, at any rate, are slipping a little bit in our incentive idea or in taking the initiative in going ahead and planning our own program and usng our own judgment to proceed as rapidly as we can toward the objective which we hope to achieve. Possibly we depend entirely too much on the other things.

You, as a leader in the field, have certainly given this some thought down through the years. Isn't it true, Doctor, that you were thinking about these things as well as other scientists a long time ago?

Dr. HAGEN. Yes, sir; that is true.

Mr. SISK. Thank you very much, Doctor. I appreciate your comments.

Thank you, Mr. Chairman.

The CHAIRMAN. Doctor, is there any consideration among scientists here or abroad of an extension of the International Geophysical Year?

Dr. HAGEN. Yes, sir, there has been a discussion among scientists and recognition of the need and the value for such an extension. It has been a very, very rewarding and pleasant experience to see this concerted action by people in many countries of the world which has brought out so many things of value. I think we should recognize that value and perhaps extend the effort.

The CHAIRMAN. Do you know of any efforts being made along that line?

Dr. HAGEN. I can't say for certain what the effort is, whether there is indeed a formal action being planned. I know there have been discussions.

The CHAIRMAN. But is it your opinion that our Government, through its proper agency, should enter into discussions if not negotiations with other countries, having in mind an extension of the International Geophysical Year?

Dr. HAGEN. I would highly recommend it, yes sir.

The CHAIRMAN. A good, healthy climate has come out of it, has it not?

Dr. HAGEN. Yes, sir.

The CHAIRMAN. And certainly the opportunity for that climate to continue through an extension might produce some beneficial results?

Dr. HAGEN. It is one way of heightening the understanding that might exist between us and any other nation that is in the organization.

The CHAIRMAN. I am not looking at it from the angle of conflicts or tensions that might exist, but the broader angle. There is no harm from anything that is good.

Dr. HAGEN. Yes, sir.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Dr. Hagen, I appreciate the information you have provided the committee this morning, and the fact that you have had experience in one of our more sophisticated thrust engines, the Vanguard.

I am curious to know if our program on developing a maximum thrust is the design of the engine or the fuels that are used. Which of the two is the more difficult to produce?

Dr. HAGEN. I think the answer to that would be dependent upon to whom you were talking. The chemical fuels people would think their job is harder, and the materials people would think theirs is harder. The difficulty is this: We are using about the highest energy fuels we can lay hands on today, safely. There are newer, more

exotic fuels which are capable of releasing more energy per pound as they burn, but there are difficulties that have to be overcome in handling these fuels. I should say that in this chemical fuel area there is a limitation beyond which one can go no further. To get even higher impulses we will have to get away from chemical fuels and employ some nuclear processes.

In making any advance in rocket propulsion, necessarily involved are problems of materials in the combustion chamber and in the nozzle of the rocket.

These materials have to withstand a higher and higher temperature and have to withstand the flow of hot gases at high velocity. This is the serious limitation in the engine itself.

Mr. McDONOUGH. But we are working on fuels that will provide greater propulsion than those we have used up to now. You say there is a limitation on the chemical fuels, but do you mean a limitation as to their maximum expansion and volatility and their ignition, the immediate ignition of them? What are the limitations?

Dr. HAGEN. The limitation is on the amount of energy you can get by burning a pound of whatever the fuel is.

Mr. McDONOUGH. Then there is a limitation on the full use of that sudden explosion in order to get the thrust, isn't there?

Dr. HAGEN. I think that problem has been fairly well worked out. The efficiency of the modern rocket engine is quite high. I can't quote the figure, but it is high compared to the efficiency of earlier engines.

Mr. McDONOUGH. We know Russia has a greater power thrust than we have, isn't that true?

Dr. HAGEN. That is right.

Mr. McDONOUGH. Is that because of the fuel or the rocket design of the engine?

Dr. HAGEN. It is difficult to say. It could be either. That is, one could take the fuels and methods that we now use and, by building a bigger engine, get the thrust that the Russians must have had to do what they did.

However, that whole problem would be greatly simplified if a more exotic and a higher energy fuel were used. Which approach the Russians used we, of course, have not been told.

Mr. McDONOUGH. To what extent have we used hydrogen gas as a propellent?

Dr. HAGEN. This has not been used, to my knowledge, to any degree. Ideally it is a good thing to use. One of the ideal propellent combinations would be hydrogen burned with oxygen, both carried in liquid form in the tanks. Herein rests a problem in that the hydrogen liquefies at a very, very low temperature, and there would be difficulties in handling hydrogen in the liquid form. However, this is one direction in which we can and will move to get higher specific impulses out of rockets.

Mr. McDONOUGH. In other words, you don't think we have reached the maximum in the use of hydrogen as a propellant?

Dr. HAGEN. No.

Mr. McDONOUGH. There isn't any other gas that we know of that would expand as quickly, is there?

Dr. HAGEN. Our propulsion people have been studying this problem assiduously for a long time, trying to find chemicals which will, in burning, release larger amounts of energies than those now in

hand. I don't believe they have come up with anything which would be an improvement over hydrogen burning with oxygen. The point I was making, though, is that burning hydrogen with oxygen would increase the specific impulses by maybe 15 or 20 percent over what we presently can achieve. So the increase that we can look forward to in even the best of the chemical fuels is not a great increase. It is on the order of 15, 20, or 25 percent. What we really need, and must develop for really long-range work in space, is an improvement far beyond this. So we have to look at something other than chemical fuels.

Mr. McDONOUGH. Speaking about the design, and presuming that we have the maximum in fuel, is the principle of a rocket engine the use of thrust against the earth into the atmosphere, and against the atmosphere into space after you have left the earth? Is that the principle of it?

Dr. HAGEN. It works against the attraction of the gravitational field. Therefore, the key element in the design of a rocket is to reduce the deadweight, the weight of the tanks, and the engine body, and to put as much of the weight as possible into the payload. The rocket then works against the gravitational field and carries the payload out away from the earth. In the satellite case, once it gets it away from the earth, the rocket has to do another job, and that is to give the satellite a high enough velocity to make it stay in orbit. In a space vehicle going to the moon, most of the energy is required in working against the gravitational field to get it out as far as the moon. There is one other point that you may have in mind, and that is the reason the rocket itself works; this is the principle of action and reaction.

A rocket goes forward for the same reason that a rowboat goes out from under you when you jump from it. The escaping gases have momentum and that momentum must be conserved.

The only way to conserve it is for the rocket itself to go forward.

Mr. McDONOUGH. In other words, the maximum thrust against it is reacted with the maximum thrust toward it, and you have to neutralize that. You are repelling the law of gravity instantly, as quickly as you can.

Dr. HAGEN. What you are doing, in order to get around gravity, is making this reactive force against the rocket equal or exceed the force of gravity, and the rocket then will rise.

There is another point that should be made here and that is that the rocket doesn't work because the exhaust is pushing against the atmosphere. The rocket would work best out in empty space, where it is exhausting into a vacuum. The fact that the atmosphere is there and the exhaust pushes into that actually makes the rocket less efficient. Our rockets work better after they get up out of the atmosphere.

Mr. McDONOUGH. But you must, to get there, push against the atmosphere.

Dr. HAGEN. No, sir; if the atmosphere weren't here, we would get away from the earth easier.

Mr. McDONOUGH. But due to the fact that the atmosphere is here, you must push against it to get away from it.

Dr. HAGEN. It hinders the motion and makes the operation less effective.

Mr. McDonough. You have the resistance at the nose and you have the gravity at the base.

Dr. Hagen. And the effect of the atmosphere on the exhaust is to prevent it from getting out of the rocket fast enough, and therefore the reactive force isn't as great.

Mr. McDonough. Are you familiar with, and are we developing, antimissile missiles?

Dr. Hagen. We mentioned that a bit earlier in a way of talking about an antisatellite missile. The only thing I would care to say this morning is that this is a difficult task but it is not something that can't be done.

Mr. McDonough. If we had an armed spaceship for military purposes, and it was out a distance of 500 miles from the earth where it would be in orbit, how could that armed spaceship shoot an object at an enemy spaceship in space?

Dr. Hagen. The same way that one ship at sea could shoot at another. He would have to do a good navigational problem. He would have to know his motion, he would have to know the distance and the velocity of the target, and when he would have to do a careful calculation of the effect of the attraction of the earth, for example, on whatever it was he shot out. But it would be feasible, for example, to put out a rocket which would travel from point A to point B.

Mr. McDonough. In space?

Dr. Hagen. In space; yes.

Mr. McDonough. Your spaceship will be traveling at, let's say, 18,000 miles an hour, and your power to eject that object from the spaceship to hit another spaceship would have to be at a greater speed than that.

Dr. Hagen. No; it is all relative. It would be much easier to shoot that object away from the spaceship than from the surface of the earth, because the gravitational attraction of the spaceship to the object would be very, very small, owing to the very small mass of the spaceship.

Mr. McDonough. Thank you very much, Doctor.

Mr. Brooks (presiding). Mr. Fulton?

Mr. Fulton. We are glad to have you here, Doctor, and I want to, as a member of the Navy Reserve, congratulate you on your success. The program has been moving according to schedule, and, as you have very adequately stated today, the context of the Vanguard program was that it was a part of the geophysical year, and it was to move on a planned procedure to have implementation to obtain scientific knowledge. It was not in the sky rocket class, nor was it in the lady-out-of-the-gun class either, as has been said here. There is no doubt, is there, that we have, in our United States program, tried a much more scientifically aimed instrumentation, than the Russians? We are really trying for a scientific purpose to find what can be learned from the orbiting of an earth satellite.

Dr. Hagen. Yes; that is correct. The entire emphasis has been upon the scientific value of the experiment.

Mr. Fulton. Under those circumstances, then, it is really unfair to compare our type of program with that of the Russians, as unfair to us to compare ours to theirs as it is to them to compare theirs to ours.

Dr. Hagen. I believe so.

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Mr. FULTON. I say that in all fairness. The question then comes: When did it become apparent to you that the Russians had changed the aiming of their program for the Geophysical Year?

When did they decide, according to your information, that they were doing something else, that they were going to take a chance and get a speedup in order to take a shot at an earth satellite in orbit?

Dr. HAGEN. I think the way to answer that is this: From the very beginning, our program was clear and open. It was openly decided to go into the program. It was openly announced by the President in July of 1955 that we were, indeed, in the program, and he stated our objectives. From that time on, the program was carried forward strictly as a science project in the International Geophysical Year.

The Russian program, on the other hand, was not so openly announced. It wasn't until the conference in Barcelona in September of 1956, I believe, that the Russians made the announcement that they were also officially doing this job as a part of the International Geophysical Year.

(EDITOR'S NOTE: Review by this committee staff shows a series of reports on Soviet satellite plans were published in the New York Times from 1951 on. See our report of May 21, 1958, pp. 204–208.)

I think events have proven that it is fair to presume the Russians started their efforts long before they made their announcement, and their effort was based upon the use of military vehicles which they had in hand at that time and we did not.

Mr. FULTON. So that actually what happened is that we then in the United States participated in the Geophysical Year on a very open, frank, free basis, with inspection being made by the scientists of Russia as well as all other countries, of the equipment that we had in the United States as well as the progress which we were making; is that not right?

Dr. HAGEN. That is correct; yes, sir.

Mr. FULTON. Then the Russians, on the contrary, concealed theirs, and, instead of cooperating on the same, frank, open basis, it became apparent at one time to even our own scientists that we were not receiving their open, free cooperation; is that not correct?

Dr. HAGEN. That is correct. And they did not make an open statement of their intention until this meeting in Barcelona, Spain, in September 1956.

Mr. FULTON. Under those conditions, it seems obvious that, for the defense of this country, there should have been a policy set which would determine what should have then been given to the Russians as a matter of information, and what should not have been given to the Russians. The reason I say that is as soon as it became apparent to our scientists that they were not dealing as openly as we were, and we in the United States then continued on our same open, free and easy way, we weren't being too smart; were we?

Dr. HAGEN. I would like to develop that point a little bit. It is too complex to give a "Yes" or "No" answer. I think it can be argued that the agreement in the IGY was that the experiments themselves, when done, would be freely described, and the results of the experiments would be freely exchanged. The procedures for accomplishing this were set up by the international IGY organization; and they are, in brief, that the results of the experiments are turned in to world data centers and to the international IGY organization in Brussels.

Mr. FULTON. Would you at this point in the record, rather than going into the details, as this meeting is getting late at this point, put in the system used by the IGY in a statement in the record at this point.

Second, would you, with the chairman's permission, put in a report of your entire calendar for the Vanguard project on its association and cooperation with the IGY.

Next would you put in a history as to the correlation of how you have met that calendar to date.

And would you likewise give us a calendar for the future on your stepped-up Vanguard proposed program.

In addition, would you give us an estimate of the various cost factors on your proposed stepped-up Vanguard program.

Likewise, if we could, to see a comparison between the Russian programs and our own programs on these earth satellites from your own point of view.

Next, I wish you would put into the record a glossary or a dictionary of the terms that you have used here of a scientific nature because we on this committee are obtaining the first official use, I believe, of many of these terms that are now being used among scientists.

I would like to ask further that, with the chairman's permission, each witness who has appeared here make his own definitions for his statements and his testimony on these scientific terms that are now becoming current.

(Material requested in the foregoing is as follows:)

1. Requested an explanation of the IGY policy on information exchange. This question was referred to the National Academy of Sciences, and the following letter constitutes their reply.

NATIONAL ACADEMY OF SCIENCES,
NATIONAL RESEARCH COUNCIL
OF THE UNITED STATES OF AMERICA,
UNITED STATES NATIONAL COMMITTEE,
INTERNATIONAL GEOPHYSICAL YEAR 1957–58,
May 9, 1958.

Dr. JOHN P. HAGEN,
Project Director, Naval Research Laboratory, Washington 25, D. C.

DEAR DR. HAGEN: In accordance with your request this afternoon, I am pleased to provide the following information on the data interchange agreements within the International Geophysical Year program.

From its inception, the full interchange of data was recognized as an integral part of the program. Agreements covering the interchange of data appear in formal form in the CSAGI Guide to IGY World Data Centers. These agreements call for the ultimate possession by each of three world data centers of all IGY data. The three world data centers which have been established are located as follows: World data center A in the United States, world data center B in the U. S. S. R., and world data center C in Western Europe with branches in Australia and Japan. These data centers will not only acquire and hold the complete sets of all IGY data but will also make their facilities available to scholars and will provide copies of all data, at cost, to investigators at their request.

The flow of data to the centers is proceeding satisfactorily. The procedures vary from field to field, depending upon the problems unique to a given area. The procedures and time schedules are presented in the guide referred to above. The international cooperation which has characterized the observational aspects of the IGY is also present in the data interchange program, and data are flowing from all parts of the world. There are also under way plans for the publication of IGY processed data; such publication will make the IGY data even more readily accessible to scholars everywhere.

In view of the specific interest in the satellite area of the House committee before which you testified, the following comments may be of interest. I have pointed out that the arrangements on data interchange vary from field to field.

In the satellite area the agreements may be summarized as follows: First, each satellite launching authority must advise all investigators (using press, radio, and IGY media) of the successful launching of a satellite as promptly as possible but within 24 hours at the latest. Second, preliminary reports describing experiments and instruments are to be interchanged within several weeks after launchings. A brief descriptive report on the first two Soviet satellites has been distributed. We ourselves hope to release some preliminary reports on the first of our satellites (1958 Alpha) within the next week or so. Third, the final results of satellite experiments are to be interchanged within 12 months after an experiment has been conducted. This timetable was based in part on the problems of analyzing telemetered data and in part from experience with rocket experiments, where a similar liberal schedule is necessary. Neither launching authority has yet issued final results of satellite experiments; each has some months of working time yet available for completing the analyses and then issuing final results

I hope that the above information clarifies the question which the House committee addressed to you, and I shall be happy to respond further as necessary.

Yours very truly,

HUGH ODISHAW,
Executive Director.

2. Requested a calendar of Vanguard scheduling and how it has been met or altered. This material follows:

The original Vanguard launching target dates are shown in the second column of the accompanying table. The objective of that schedule and subsequent changes has always been and still is to maintain a working schedule designed to assure launching of a 20-inch scientifically instrumented satellite during the International Geophysical Year. The period of the IGY is July 1957 through December 1958. The scheduled dates of proposed firings have always depended on the progress in development of the Vanguard launching vehicle. Because of this factor the schedule is in two segments:

(*a*) A test vehicle series, numbered TV–0 through TV–5 The purpose of these launchings was to check the performance of the vehicle and systems during the development program. Originally 9 test vehicle flights were planned, including 3 backups to be used in case of an unsuccessful test. For instance, the December 6, 1957, test of TV–3, which did not result in a successful flight, was backed up by the TV–3 backup vehicle launching on February 5, 1958. Although this flight was only partially successful it was possible to proceed on to TV–4, which placed a small test satellite in orbit on March 17, 1958. Thus TV–5 could follow TV–4. The TV–4 backup vehicle, no longer needed in the test series, is being converted into a full-scale IGY satellite launching vehicle.

(*b*) The second phase of the schedule consists of a satellite launching vehicle series, initially consisting of 7 vehicles numbered SLV–1 through SLV–6, but now increased to 7 by the additional of the converted TV–4 backup vehicle. Each of these vehicles is intended to launch an IGY scientific satellite. Originally, it was hoped that the test vehicle part of the program would be completed in time to permit the launching of SLV–1 in late 1957. Currently this first IGY satellite launching is scheduled for the spring of 1958.

The table shows the original working schedule and subsequent changes The changes have been carefully designed to take advantage of successes and information gained in the developmental and test program as well as to accommodate the time required to solve problems. For example, see footnote 3 of the table. The future launchings are planned at the rate of roughly 1 every 4 or 5 weeks; the exact dates are classified information.

Comparison of Vanguard vehicle tentative launch schedules

Vehicles	Date of working schedule for launchings					Actual launch
	November 1955 launch	March 1956 launch [1]	February 1957 launch [2]	October 1957 launch [3]	December 1957 launch [4]	
TV-0	Sept. 27, 1956					Dec. 8, 1956.
TV-1	Nov. 29, 1956	Jan 29, 1957	Apr. 25, 1957			May 1, 1957.
TV-2	Jan 31, 1957	Mar 8, 1957	July 26, 1957			Oct. 23, 1957
TV-2BU	Backup	Apr 19, 1957	Sept 6, 1957	Backup		NS.
TV-3	Mar 29, 1957	May 24, 1957	Oct. 15, 1957	Dec. 4, 1957 [5]		Dec. 6, 1957.[5]
TV-3BU	Backup	June 21, 1957	Backup	Jan 8, 1958 [5]	Jan. 18, 1958 [5]	Feb. 5, 1958.[5]
TV-4	May 30, 1957	July 26, 1957	Dec. 16, 1957 [5]	Feb. 12, 1958 [5]	Feb. 10, 1958 [5]	Mar. 17, 1958.[5]
TV-4BU	Backup	Aug. 23, 1957	Backup [5]	NS [5]	Nov. 19, 1958	
TV-5	Aug. 1, 1957 [5]	Sept. 20, 1957 [5]	Feb 14, 1958 [5]	Mar 19, 1958 [5]	Mar. 4, 1958 [5]	Apr. 28, 1958.[5]
SLV-1	October 1957 [5]	Oct. 31, 1957 [5]	Mar 21, 1958 [5]	Apr. 23, 1958 [5]	Mar 24, 1958 [5]	([6]).
SLV-2	December 1957 [5]	Dec. 6, 1957 [5]	Apr. 25, 1958 [5]	May 28, 1958 [5]	Apr 28, 1958 [5]	([6]).
SLV-3	February 1958 [5]	Jan. 14, 1958 [5]	May 30, 1958 [5]	July 2, 1958 [5]	May 26, 1958 [5]	([6]).
SLV-4	April 1958 [5]	Mar. 28, 1958 [5]	July 3, 1958 [5]	Aug 6, 1958 [5]	June 23, 1958 [5]	([6]).
SLV-5	June 1958 [5]	May 23, 1958 [5]	Aug. 8, 1958 [5]	Sept 10, 1958 [5]	July 21, 1958 [5]	([6]).
SLV-6	August 1958 [5]	Aug 1, 1958 [5]	Sept 12, 1958 [5]	Oct 15, 1958 [5]	Aug 18, 1958 [5]	([6]).

[1] Both the General Electric Co. (1st-stage engine) and the Aerojet-General Corp. (2d-stage engine and tankage) had determined that more time than that reflected in the November 1955 schedule would be required to meet the specifications on weight and performance

[2] During the late fall and winter of 1956–57 the Martin vehicle development program ran into difficulties (*a*) 1st-stage engine (GE) Scoring and burnouts, performance below specifications, and injector redesign (*b*) 2d-stage engine and tankage (Aerojet) Injector redesign, vehicle design changes that affected 2d-stage design, many rejects because of difficult component fabrication, and tank fabrication problems required new approaches (*c*) The 3d stage. Overweight and required additional development to meet weight and performance specifications (*d*) Structural· It was suspected that the structural design of the vehicle was inadequate to withstand the vibration loads. Design and production was stopped until the problem was resolved

[3] The successful firing of TV-1, which showed that the 3d-stage design was adequate, made it possible to revise the test program to include test satellite firings starting with TV-3. This is appreciably earlier in the program than had been thought possible before. The revisions to the test vehicles to accommodate these changes produced the delay shown

[4] The ability of the Martin Co. to increase the delivery of the vehicles and the provision of additional personnel at AFMTC permitted a schedule revision It was decided that the static firing of the 2d-stage engine at AFMTC accomplished no major useful purpose, thus this and several minor tests were eliminated, which, coupled with the other improvements outlined above, resulted in this schedule revision.

[5] Vehicles having satellite launch capabilities.

[6] Remaining vehicles planned 1 each 4 or 5 weeks; schedule planned to be completed by December 1958

3. Requested a calendar for the proposed advanced Vanguard program and an estimate of costs for this program. This material follows.

Brief of proposed Vanguard Post—IGY space research program (unclassified portion only) (U. S. Naval Research Laboratory, Washington, D. C.—Project Vanguard)

1. *Program description.*—Project Vanguard is the name applied to the Department of Defense satellite project designed to establish at least one scientifically instrumented spherical satellite in a sustained orbit around the earth before the end of the International Geophysical Year (IGY) (December 31, 1958). Technical management of the program is the responsibility of Project Vanguard established at the United States Naval Research Laboratory to perform this mission. This initial mission will have been completed and most or all of the available vehicles launched around the end of 1958. Because of the long lead-time required for procurement and especially the time required to plan a logical, sensible, and scientifically worthwhile space project, Project Vanguard has requested immediate authority and funds to initiate a program utilizing the in-being management and technical competence of Vanguard, built up since the fall 1955. The essential features of this program are:

(*a*) To develop satellite systems with up to 50 pounds payloads using improved Vanguard launching rockets as carriers. These rockets can be made available starting before the end of the calendar 1958 provided immediate go-ahead is authorized. The improved Vanguard is simply the current Vanguard with an improved third stage which is under development.

(*b*) To employ existing Vanguard personnel and facilities plus other diversified naval research laboratory capabilities to provide program management, scientific and operational instrumentation, satellite tracking, vehicle, orbit and scientific data analysis, and including research and development.

(*c*) To make optimum use of Vanguard capabilities by replacing the first stage booster in the Vanguard vehicles with more powerful first-stage boosters. As earth-satellite carriers these vehicles would provide payload capacities of several hundred pounds dependent on inclination and direction of launch with respect to the earth's equator and rotation. These model III Vanguards could also serve as lunar research vehicles. It is to be noted that the unique Vanguard launch facilities at Cape Canaveral provide the guidance capabilities required for lunar flights.

2. *Program functions.*—The proposed Vanguard post-IGY program is a complete functional program containing all of the elements necessary for a complete program of space research. It is especially attractive since the project is the only one in existence which has all of the combined capabilities required under one roof and a single project director. These functions include:

(*a*) *Radio tracking.*—Maintenance, operation, research and development and increased capability of the Vanguard tracking network.

(*b*) *Telemetering.*—of data on vehicle performance in addition to the prime function of telemetering scientific and/or operational data from the satellites.

(*c*) *Satellite instrumentation.*—The early satellites accrue certain obvious political impacts just by maintaining an orbit, being of a certain size or other features which will diminish in value as they become more common Then, their real value will be more rationally assessed in terms of their scientific worth. This program includes the necessary scientific skills to conduct a program to develop instrumentation of a sophisticated nature. The Naval Research Laboratory's 12 years of experience in high altitude upper atmosphere instrumented rocket research provided the know-how for Vanguard. In this area, Vanguard seems to be temporarily ahead of the country's closest competitor. Only an adequate program now, will maintain this position.

(*d*) *Payload packaging and development.*—Current satellite internal and external configurations are not the final answer. This function must be performed in conjunction with instrumentation development and in consonance with vehicle design and performance characteristics. The package is a part of the vehicle structurally and in other respects. The program includes the scientific engineering effort required for further development in this area.

(*e*) *Theory, data processing and analysis.*—This includes all aspects of the data function from theory through analysis of data on trajectories, orbits, design requirements, range safety, ad infinitum.

(*f*) *Vehicles and launching.*—The manufacture of vehicles and physical launching effort is of course, contracted for. The Vanguard vehicle development was based on previous experience of the NRL vehicle staff in developing

very high performance rocket research vehicles such as Viking. The proposed program includes development effort on the improved and advanced Vanguards.

(*g*) *Other functions* such as some communications, logistics, range use and support are performed by the three military departments' facilities as available. It is assumed that these and additional Government facilities will continue to be used and available for space-research purposes. Roughly 85 percent of Vanguard dollars are spent at private contractor facilities.

3. *Program schedule.*—The fixed points in time at which various phases of the program can be completed depend on the date the go-ahead is given and sufficient funds made available. The Vanguard-IGY program has now progressed to the point where each day's delay in authorization of a post-IGY-Vanguard program is translated into additional delay of the advanced program (this condition has existed since January 1, 1958). Delay in go-ahead also increases costs because production lines, facilities, and especially management and research teams are expensive to reassemble once they have been closed down or atrophied.

If the go-ahead were given by June 1, 1958, the first firing of the improved Vanguard (50-pound satellite) would be in early spring 1959, almost immediately after the end of the current IGY series of launchings. The advanced Vanguard (larger satellite and space research craft) series would begin in about 2 years. This assumes a very high priority on procurement and use of facilities.

4. *Program cost.*—To conduct a complete program encompassing advanced work, operations, and research and development would require a level of about $50 million a year for the next 3 years (fiscal years 1959, 1960, and 1961). The costs beyond that point would depend of course, on accomplishments, progress, and program objectives which cannot be determined precisely enough for cost estimating now. It is suggested that an annual basic level of $50 million would guarantee a very sophisticated and advanced program.

4. Requested a comparison between the Russian programs and our own programs and our own programs on earth satellites. This material follows.

We have never been told in explicit terms what the Russian program for earth satellites is comprised of. It is known, however, that the Russian program aims in rockets and satellites are similar to our own in that they are mainly directed toward the measurement of geophysical quantities and of the solar and cosmic radiation high in our atmosphere. To date the Russians have had two successful launchings. Their first satellite apparently was mainly a test satellite; the second measured solar and cosmic radiation and in addition carried a live dog as an experiment in space medicine.

The Russian satellites and launching vehicles have been larger and heavier than any of the three we have launched.

5. Requested a glossary or dictionary of scientific terms coming into official use. I am informed that the clerk of the committee is attending to the acquisition of such a glossary, and that it need not be submitted by me.

6. Requested my own definitions for scientific or technical terms used in my testimony. This material follows:

Glossary of Technical Terms Used by Dr. Hagen in His Testimony

1. Acceleration—any change in the magnitude or direction of the velocity of an object. Linear acceleration may be thought of as the rate of change of the object's speed. For example, an acceleration of 2 feet per second means that an object's velocity is increased by 2 feet per second during each second of time that elapses.

2. Backup—an alternative, a provision against delay or failure of a planned device or objective, a replacement or substitute.

3. Decay—as applied to orbits, the loss of energy by the satellite resulting in shrinkage of the orbit.

4. Drag—the retarding force exerted upon the satellite or rocket by atmospheric friction.

5. Mass—that property of matter which exhibits inertia, or resistance to change, in motion, and has weight when in a gravitational field. The net force exerted on an object, divided by the resulting acceleration.

6. Orbit—the path of an object which revolves about a larger or primary object under the influence of a gravitational field.

7. Payload—the useful weight carried by a rocket vehicle, the weight associated with the actual performance of the final objective as distinguishd from

the weight of the rocket's system itself. Example: Vanguard has in orbit some 55 pounds. Only the 3½ pound weight of the satellite sphere itself constitutes a payload.

8. Period—the time rquired for one complete circuit of the earth by an orbiting satellite.

9. Perturbation—any deviation in the orbit of a satellite due to a disturbing force.

10. Propellent—any of the substances whose chemical combination or burning produces the thrust of a rocket. Propellents of a given rocket stage consists of a fuel and an oxidizer. Depending on the particular rocket, both propellents may be either liquid or solid and may be stored separately or as a mixture.

11. Reentry—the descent into the earth's atmosphere of an object launched into space.

12. Satellite—any object in an orbit about a larger primary body.

13. Solar cell—a photosensitive device for converting sunlight into electric power.

14. Specific impulse—the magnitude of the thrust derived from burning propellents at a given rate.

15. Stage—a rocket which together with other rockets makes up a composite vehicle. A given stage is separated from the remainder of the vehicle after it has fulfilled its function.

16. Thrust—the propelling force imparted to a rocket by the exhaust from its engine.

17. Trajectory—the path of an object fired or projected from one point toward another point. A trajectory is distinguished from an orbit by its finite length.

18. Vehicle—an object or device designed to transport another object or device. A satellite launching vehicle is a device to lift a satellite payload above the sensible atmosphere and discharge it into an orbital path at a given speed.

19. Velocity—the rate and direction of a moving object. Loosely, the speed of the object

20. Weightlessness—the absence of any net gravitational force upon an object relative to its immediate surroundings. An object or creature inside an orbiting satellite, for example, will experience no weight.

Mr. Brooks. I notice particularly the indefiniteness on some of the points that have been made here this morning, when the comment had been made by Mr. Sisk to project a payload, object, or otherwise. You can't tell what that means.

Nor can you tell what you mean when you said "All these satellites going through the air." You didn't mean air, you meant atmosphere.

Dr. Hagen. Yes, sir.

Mr. Brooks. Or space.

If the gentlemen would yield, before any more members of the committee get away, and we have lost some already so they will have to be notified, the chairman asked that the committee meet again this afternoon. The time of the meeting this afternoon would be dependent on the time we recess at noon.

What is the pleasure of the committee?

It is my thought, and it is noon now, that if we adjourn now or within the next few minutes, we can meet at 2. But if we go over until 12:30 or a quarter to 1, and either one would be all right with the Chair, that then we would meet at 2:30. What is the pleasure of the committee?

Mr. Fulton. Could we suggest meeting at 2, and then if you would appoint a substitute chairman if you have to go to the floor——

Mr. Brooks. I will stay here as long as the gentleman wants to stay. If he wants to go straight through to 2 o'clock, in order for him to have the opportunity, I will sit with him and go without lunch or have sandwiches sent here, either one.

Mr. Fulton. I will only take about 5 or 10 minutes more.

Mr. Brooks. Very well.

Mr. Fulton. For example, the use of the words "vehicle," "missile," "rocket," I would like specifically explained in your glossaries, as well as what are meant by "manned or unmanned guided vehicles," "missiles in space," and whether they are powered either internally or externally.

We need some sort of a definition that we could come up with, some language that is going to be mutually accepted among the scientists and the legislators. We are each talking our own kind of a jargon.

How much money would it take you, and in what period of time would you need it, to put full speed ahead on the advanced Vanguard program?

Dr. Hagen. I think to complete the first step in the advanced Vanguard program, and to obtain a sufficient number of vehicles to do useful work, the total national cost of this would be something on the order of $50 million.

Mr. Fulton. How much?

Dr. Hagen. $50 million.

Mr. Fulton. And within what period of time? How soon would you need it? And give us the order of magnitude of the partial payments to you.

Dr. Hagen. Approximately half of this would be needed upon determination to go forward with the program, and the remainder would be required before the end of the next fiscal year.

The vehicle launching part of the program could be handled within 1 or 2 fiscal years depending upon the desires of the Department.

Mr. Fulton. There was a dispatch from Reuters yesterday, saying that the United States Government was going to make a shot to the moon on Wednesday of this week.

From your own information, and from that of your Department, can you deny that you are going to make such a shot?

Dr. Hagen. I can testify, sir, that I am not going to make such a shot.

Mr. Fulton. And nobody, to your knowledge?

Dr. Hagen. To my knowledge, nobody.

Mr. Fulton. All right, that lays another rumor aside. The Air Force is now in charge of the rocket shot to the moon, and your project is contributing by the use of certain Vanguard equipment, which we will not go into. Is that the best setup for the shot to the moon, to get it done quickly, or should there be more authority given to the Vanguard project on equal participation?

Dr. Hagen. Well, I believe that in block diagram this is a proper approach, but that the net effectiveness of the approach could be improved if more of the Vanguard techniques as well as hardware were used.

Mr. Fulton. But, as a matter of fact, when it is done on that basis, through the Air Force, using some of your hardware and equipment, isn't that robbing Peter to pay Paul? You would be having other scientific programs going ahead on the Vanguard project if you were not deprived of the materials to go over to the moon shot under the Air Force.

Dr. Hagen. Whether it would rob Peter to pay Paul would depend somewhat upon the arrangements made for the method of doing the

job. The acquisition of the hardware for this job by the Air Force, for example, would not necessarily penalize the Vanguard program.

Mr. FULTON. The inference of my remark is: Should we not prepare to have further funds given so that the Vanguard program is not penalized through part of its hardware being taken away for a specific lunar shot?

Dr. HAGEN. Yes, sir. I think my answer to that would be "yes."

Mr. BROOKS. Will the gentleman yield?

Do I understand the doctor to say that the moon shot is retarding the Vanguard program?

Dr. HAGEN. No, sir, I don't believe I said that. I said that the acquisition of the hardware, Vanguard hardware, by another service, by the Air Force, does not interfere with the Vanguard.

Mr. FULTON. But if you had further funds to go ahead with other hardware, it would facilitate your program rather than looking at the other side of it, that it is penalizing it to take this other step?

Dr. HAGEN. That is correct.

Mr. FULTON. Might I say further that I am surprised that you have dismissed so completely the possibility of meteorite contact with the satellite in your 200-year projection for its life.

How high is your apogee on that?

Dr. HAGEN. 2,463 miles.

Mr. FULTON. So for a space of 2,463 miles as a radius, you are then really saying there is very little danger of satellite collision with meteorites in a 200-year period?

Dr. HAGEN. Destructive collision. Within that period there will certainly be collisions with meteors. But, as you know, most of these meteors, even those you see as so-called shooting stars, are very tiny things. The probability is high that there will be collisions of things like this with the satellite; however, the chance of their doing much harm is not great. They can puncture the thing and go through it, and unless they happen to hit the small transistor or the oscillator, or one of the wires, they can do no damage. They can do some damage by gradually eroding away the surface of the satellite, and eroding away the solar cells. But the rate at which that erosion will take place we are now determining in the IGY program. I don't believe that it will be so high as to endanger the life of this satellite.

Mr. FULTON. On your own statement, then, as it erodes, those pieces travel right along with it, so it will really turn into just being a cloud of little vehicles, finally, and still going around, will it not?

Dr. HAGEN. Yes, but, since these vehicles will now be separate entities, the drag effect on them, because they have separated from the larger mass, will be different, and they will be spread out along the orbit.

Mr. FULTON. In answering Congressman McDonough, of California, you said the firing from missile to missile, or satellite to satellite in outer space might be like between ships. I am sure that on a military premise, you do not mean that the explosions would take place there so that you could destroy a satellite in the same way, as there is no air. If we have an explosion in outer space, then it simply means giving various minute particles either a different orbit, arc, or straight line thrust.

Dr. HAGEN. The parallel I meant to make was in the problem of the trajectories. As far as the ability to destroy is concerned, it would

be more akin to the use of shrapnel, that one could or would explode a warhead in space, and when he does so, pieces are going to fly away.

Mr. FULTON. Yes, but then you would have a tremendous number of so-called vehicles or pellets moving around up there.

It would be like running through a gravel storm.

Dr. HAGEN. Yes, sir, that is correct.

Mr. FULTON. Now let us look at your 200 years, too. To see what the limits we on this committee should set for our outer space, the taxpayers require us to keep within certain bounds. For example, on the 200 years, there are 31,536,000 seconds in a year. So at 5 miles a second for 200 years, multiply our 31,536,000 by another 1,000, gives us 31,536,000,000 miles the satellite is going in 200 years.

If it is going 31½ billion miles, it will go around the earth in—let's see how that would work out. At 5 miles a second, it is going around the earth about 16.28 times a day. So in 200 years it is going to go around the earth about 118 million times.

Isn't that a tremendous use of energy?

Dr. HAGEN. Well, due to the fact that out in this region there is so little atmosphere left, therefore so little friction, then the energy we put into this satellite is going to be very effectively used.

On the plane last night, I did some arithmetic similar to yours. I don't know whether my answer is exactly the same, but it is in the same——

Mr. FULTON. I did it while I was sitting here.

Dr. HAGEN. Period. The total distance, if the Vanguard satellite stays up 200 years, the total distance is going to be on the order of 26,000 million miles.

Mr. FULTON. I have thirty-one thousand five hundred—thirty-six thousand million miles. (EDITOR'S NOTE: Verified as correct.)

Mr. KEATING. Split the difference.

Mr. BROOKS. I think that is fair.

Mr. FULTON. The question is this, in relation to outer space, though. We have to look at the problem probably on a planetary system, because of the speeds at which we are talking, 5 miles a second. If you took 1 light year, that would be 6 trillion miles, and if the nearest star is 26 trillion miles away, the distance our satellite, that you put up, will go in 200 years is inconsequential, being only 31½ billion miles.

Dr. HAGEN. It would take the Vanguard satellite, going at the speed it is presently going, about 200,000 years to get to Alpha Centauri, one of the closest stars. It would take it in round numbers approximately 10 years to get as far as the outskirts of our own solar system. The point that this brings up is that one of the problems that we have not in this country, as far as I know anywhere in the world, effectively attacked as yet—the matter of developing thrust devices which can go in these space vehicles and slowly build up their speeds far beyond the speeds with which we are now accustomed.

Once the vehicle gets far out into space, where the gravitational fields are weak, then the application of a very small thrust over a long period of time could bring the velocity up to many, many times the velocities that we are now talking about, and these ages and years can be reduced in number.

Mr. FULTON. May I say as a compliment that I have, prior to the Vanguard shots, worked down there at the Cape Canaveral as a Navy

officer on duty, not as a Congressman, and have been impressed with the efficiency and the dedication, and, likewise, acceptance of danger of the various scientists and technicians who have been working on the Vanguard and the other rocket and missile programs.

Don't you think it is necessary that we have some sort of a policymaking body, or that we in this resolution should come up with some method of setting the policy for our scientists? Obviously, there has been no overall policy, security policy, set for the Vanguard program. This is a new field of science. Why, then, don't we have another kind of a policymaking body that will make sure we are not giving away vital secrets if the Russians aren't being open? Wouldn't you agree that that should be set out?

Dr. HAGEN. Yes, sir. I believe that this is something that should receive the kind of detailed attention which it probably cannot receive today from the very high level groups which discuss this point.

I think this is the point you are driving at.

Mr. FULTON. I might say to you that I am accidentally a Congressman. I was elected without making a speech when I was in the Pacific in World War II. I was aiming to be a mathematics teacher at one time. I have gotten diverted a little bit. Let me ask you this: Why are scientists now making these treks to Russia so much?

I understand there is one New York City scientist associated with one of the institutions, who is making his second trip to be wined and dined.

Why is he so often going to Russia? Is there any need of that?

Dr. HAGEN. I don't know.

Mr. FULTON. Not why this individual, but what is the need of them all flocking over there now?

Dr. HAGEN. I think one point in need is that we can determine very, very little about the capabilities and the plans and the hopes of the Russian scientific community by what one reads in the journals and in the newspapers; that there is only one really effective way to evaluate their performance and to evaluate their intention, and that is to have an opportunity to visit them at home, and to see what their achievements are, and to have the ability to ask questions.

Mr. FULTON. How nearly before the successful launching of the first sputnik in point of time were the Russian scientists given full and free access to all of our facilities here and your plans in the United States?

Dr. HAGEN. It happened to be about the month preceding the launching of the sputnik.

Mr. FULTON. In August, was it?

Dr. HAGEN. Starting in late August and going through September.

Mr. FULTON. Around August 26?

Dr. HAGEN. Yes.

Mr. FULTON. If that was done, it was very likely, then, that they got the latest of our developments, and the latest calendaring that we had so that not only could they see what we were going to do, but they could also calendar our operations to figure out in what length of time, competitively, they would have to act first, couldn't they?

Dr. HAGEN. Yes, I think that is probably true, they had more of an opportunity to do that than we certainly had.

Mr. FULTON. So, really, they not only had the benefit of the eagle's back, so that they, like the canary, could jump the extra 3 feet, but they

could find when the eagle was going to do it, and then they could take the jump first.

Dr. HAGEN. This is due to the method of operation. This is undoubtedly true. They had this advantage over us.

Mr. BROOKS. Will the gentleman yield again?

Mr. FULTON. Yes.

Mr. BROOKS. We actually announced the exact date that we expected to launch the satellite.

Dr. HAGEN. That was at a later date.

Mr. BROOKS. It was?

Dr. HAGEN. Yes.

Mr. BROOKS. Did I understand you to say that they had full access to our facilities here?

Dr. HAGEN. I should qualify that. They had full access to certain parts of our facilities. I should make clear that at the time the satellite effort was announced by the White House and then by the Department of Defense, it was made clear that there were certain aspects of the Vanguard-rocket which would remain classified.

Mr. FULTON. As a missile program distinguished from a satellite vehicle program.

Dr. HAGEN. Yes. And the only commitment we made was that the satellite itself and all that was in it and all of the results that came out of it, would be freely exchanged.

Mr. BROOKS. I sponsored the program to set up that base. In fact, I introduced the bill that set up the base down there at Canaveral, in Florida. Do they have complete access to that facility?

Dr. HAGEN. No, sir. I don't think one of them has ever been on it.

Mr. BROOKS. That is the point I wanted to clear up.

Dr. HAGEN. Nor do they have complete access, for example, to a laboratory here in Washington. They have been allowed to visit certain restricted areas in the laboratories, where work on unclassified things has been done.

Mr. BROOKS. Or to Wright-Patterson? Have they had access to Wright-Patterson?

Dr. HAGEN. I can't answer that. I wouldn't know.

Mr. FULTON. Could we have your agency put in, then, the calendar of the Russian visits to your installations, and also who they were, what their qualifications were, and what access they had to various types of facilities and consultations.

(The material referred to is as follows:)

On October 7, 1957, a tour of the Vanguard facilities at NRL was conducted for members of a conference on rockets and satellites held at the National Academy of Sciences in Washington This was a conference held by the Comite Special de l'Annee Geophysique Internationale. Among the visitors were three Russian scientists: Lt. Gen. Anatoly A. Blagonravov of the Soviet Army, a ballistics expert and member of the Soviet Academy of Sciences; Dr. Sergei M. Poloskov, a physicist associated with rocket and satellite experiments; and Mr. A. M. Kasatskin, associated with rocket and satellite instrumentation.

The visitors were shown research instrumentation used in the Aerobee rocket program for the IGY; they were addressed on the subject of cryogenic research by Dr. Henry of the solid state division; they were shown some shock and vibration test equipment associated with our satellite testing in the mechanics division; they were conducted through the shops where Vanguard satellites and scientific instrumentation were being assembled; and they visited the Vanguard control center, where they viewed the communications room through a window but did not enter.

The IGY is concerned only with scientific experiments, with earth satellites and orbits, and not with the rocketry per se or with military devices. This policy was adhered to in the tour, which was on a completely unclassified basis.

Mr. FULTON. You had said there was a tremendous urgency about the space program. Do you believe that it should be implemented immediately?

Dr. HAGEN. Yes, sir, I think it should. Because of the long lead times involved here, which I referred to before, if we hope to stay with this field we should no the planning that I feel needs to be done, we should do that immediately, and we should then get on with the job.

Mr. FULTON. Do you favor the immediate starting of a project for a third of a million pound thrust engine?

Dr. HAGEN. On general principles, I believe we should proceed with the development of an engine of much higher thrust.

Mr. FULTON. Would you favor also the million pound thrust?

Dr. HAGEN. This is what I was leading to. I believe we should go for an order of magnitude improvement in thrust. I think we could do that safely even before the planning procedure has been gone through, because it is clear that if we are to do anything much beyond what we presently are capable of doing, we must have a higher thrust engine.

Mr. FULTON. I believe the Defense Department has allocated $500,-000 on an annual basis so far on study funds for the million pound thrust engine, or the engine of a greatly increased magnitude. Is that right?

Dr. HAGEN. I have not been exposed to the details of this item.

Mr. FULTON. I can say to you that is about the amount. How long do you think it will take to develop a million pound thrust engine?

Dr. HAGEN. If all went well, I think we would be very fortunate to have an operating engine in anything less than 2 or 3 years. It would take a long time.

Mr. FULTON. And how many millions of dollars would it cost for the research and development of the million pound thrust engine?

Dr. HAGEN. Judging on the basis of my experience with the smaller engines, I would expect the cost of such a development to be greater than $100 million.

Mr. FULTON. So that at the rate of $500,000 annually on appropriations, it would take 200 years' worth of money in order to get the million pounds thrust engine going if we just keep on at the same rate of study?

Dr. HAGEN. I don't know how you arrive at that same——

Mr. FULTON. Well, a half millions dollars a year we let you have for study, and you say it is going to take $100 million.

Dr. HAGEN. I am sorry. I was struck with the similarity of that number to the lifetime figure we were using. I believe that this initial effort should be used to determine the feasibility of going ahead, and then, if it is proven to be feasible, certainly we are going to have to accelerate the rate at which we spend money.

Mr. FULTON. That brought up this point, and I was going to ask it, for you to give us a short calendar of amounts and timing. How soon would you need the first money? Maybe $15 million in the next fiscal year to start with, or $25 million? How much would be an adequate program for the original basic study on laying out the plans?

Dr. HAGEN. I don't believe I could give——

Mr. FULTON. Could you insert that into the record?

Dr. HAGEN. I could do that.

Mr. FULTON. I would like to get the planning, so that we can make a recommendation on the committee level as to what should be done.

(The document referred to follows:)

The development of a rocket engine with a thrust of 1 million pounds would require several years of research, development, and testing. The research and development would be principally in the area of high-energy fuels, heat transfer, and materials resistant to abrasion at high temperatures. In order to obtain a reliable motor in the shortest time, an intensive effort would be required in the first year of research and development. Funds to start such a project are difficult to estimate but should be at least $10 million for the initial year's effort, $40 million for the second year, and $50 million for the last year and first prototypes. A basic study to lay out plans would cost in the neighborhood of a few hundred thousand dollars.

Mr. FULTON. Do you favor a great advance in the research on these hypergolic fuels for the second-stage Vanguard, or would you move to something else? Would you emphasize the solid-fuel propellents? Where would you put the emphasis? We can't do it everyplace.

Dr. HAGEN. You understand when you ask that question that you get right into the middle of a strong argument between the propulsion people.

Mr. FULTON. Would you put a statement into the record?

Dr. HAGEN. For the long-range problem, I believe that we should put our greatest effort in chemical fuels in the solid-propellent engine for the purposes for which we are discussing this today.

Mr. FULTON. Then would you continue a program of research on the ion propellent?

Dr. HAGEN. Yes, sir; because that would be used for a different purpose. This is that low thrust, long-burning device which is needed for later use.

Mr. FULTON. And you really need that for guided power on outer-space vehicles, don't you?

Dr. HAGEN. Ion or its equivalent; yes, sir.

Mr. FULTON. Do you think there is any practical use in continuing with a research program for light propulsion?

Dr. HAGEN. I don't believe that I could give an answer to that, except to say that——

Mr. FULTON. Would you put it into the record later?

Dr. HAGEN. That it should be considered later.

Mr. FULTON. It should be?

Dr. HAGEN. Yes.

Mr. FULTON. There is enough there to have it considered on a study for the future, rather than to have a tremendous expansion of the proton program?

Dr. HAGEN. Only for study.

Mr. FULTON. Let me just finish with this point. When you bring up your theory of the planning of a national policy for the United States for outer space, you are talking philosophy, and that brings up the point as to how the United States should advance into outer space. From what you say, I would conclude that we should have a United States program that we effectively plan as a governmental project and as a governmental project administered. Is that right?

Dr. HAGEN. Yes, sir. That is exactly right.

Mr. FULTON. Secondly, that the Government itself should take the policy control and aiming of the direction of scientists largely employed by the Government in a space agency which is a Government agency; is that right?

Dr. HAGEN. In this one area, yes.

Mr. FULTON. You are really negating a very important field. You are saying that business should not do the planning, and the competitive United States system should not move into outer space other than under the policy control of the Government; isn't that right?

Dr. HAGEN. I believe it is the United States program, and the Government should plan what it is doing; yes.

Mr. FULTON. I think you have settled in your own mind that our United States national space policy should be on a broader base than simply a race in competition with Russia and her satellites?

Dr. HAGEN. Yes, sir.

Mr. FULTON. That puts you with a peculiar group. Historically speaking, for example, Grotius was the man who came up with the "freedom of the seas." Then along came a man named John Selden of England, in 1635, who came up with the policy for Britain of dominion of the seas. "Freedom of the seas" means that nobody has done anything about it much, and the satellites are up there. I think Congressman McDonough, of California, was a pretty good exponent of that position, and it is a rather laissez faire position—let it just ride along until something happens, until there is a collision, or let anybody do anything they want, there is no law about it, and then see what happens.

However, John Selden said that you must have the power to control, the power to dominate, although you don't actually try to dominate all the space, as Britain certainly couldn't dominate the seaways of the world. General Putt, in his testimony, clearly outlined the military approach, which is, "We must have the power to control by military means whatever outer space is near the earth and likely to have any effect on our security." Your position, though, is one that I favor when you say, "We should have an international conference." Is that right?

Dr. HAGEN. That is correct; yes.

Mr. FULTON. The second thing—an international conference would have to be called by the President. So, I have recommended previously that this committee make a policy recommendation to the President to take this question of an outer-space international conference up at the summit. Would you go along with that?

Dr. HAGEN. Yes, sir.

Mr. FULTON. That brings us to this point: We tried to cut across this freedom-of-the-seas policy, and, also, to cut across the policy of dominion of the seas, in 1899, when we were one of the major powers. There was an international conference called of nations to see if we couldn't come up with some sort of a permanent peace body. As you know, the International Court at The Hague resulted from it. Then, rather peculiarly, in 1907, there was a second Hague Conference called at the invitation of Russia, and the United States accepted. So, there is a previous historic precedent for the calling of an international conference. It was actually called by Russia. The question that we would have on this, my question, would be, and I would say it, too,

you would then not favor putting this space problem and space policy of the United States under the United Nations, either in the General Assembly, where there is no veto, or in the Security Council, where we would run into big power and veto problems, would you?

Dr. HAGEN. I am afraid that I don't know enough about the operation of the United Nations and the feasibility of using it in this way to know whether this is something that should be recommended. It doesn't appear that it should be.

Mr. FULTON. But the trouble with the United Nations is that all the nations of the world and some of the big powers are not now in it. Red China is not now in it. So, your recommendation for an international conference is, actually, a conference for every nation of the world, isn't it?

Dr. HAGEN. Yes, sir; that is right. It would have to be.

Mr. FULTON. "I believe it would have to be"; is that what you said?

Dr. HAGEN. Yes.

Mr. FULTON. So, your recommendation is that we have an international conference of all the nations of the world to take up the problems of the peaceful use of outer space, and, likewise, to set up some sort of a judicial system that might be agreed upon by multilateral treaties?

Dr. HAGEN. That is correct.

Mr. FULTON. Thank you. You have been very clear.

Mr. BROOKS. Doctor, may I ask you this question, along the lines of those which have just been asked by my colleague, Mr. Fulton? Russia was a party to this international geophysical agreement. Was that a treaty or was that an agreement?

Mr. FULTON. No, sir; I believe this was simply an agreement.

Mr. BROOKS. Was it a formal agreement?

Dr. HAGEN. It was a formal agreement on the part of two international scientific groups, each of which represents its country in either an official or a quasi-official manner. This country was represented by the National Academy of Sciences.

Mr. BROOKS. The point I am getting at is this: Russia being a party to that, you, from what you have said, feel that Russia has violated its agreement.

Dr. HAGEN. I feel that the Russians may not have violated the letter of the law in the agreement, but what the Russians did not do was to present their plan as openly and as freely as we did.

Mr. BROOKS. In other words, they violated the spirit of the agreement rather than the letter?

Dr. HAGEN. Yes.

Mr. BROOKS. It is now 12:40, gentlemen. If there is no objection, the committee will stand in recess until 2:30. You can be back, can you, Doctor?

Dr. HAGEN. Yes, sir.

Mr. BROOKS. If there is no objection, the committee stands in recess until 2:30.

(Whereupon, at 12:40 a recess was taken until 2:30 p. m. of the same day.)

AFTERNOON SESSION

The committee reconvened at 2:30 p. m., upon the expiration of the recess.

The CHAIRMAN. The committee will be in order.

Mr. FULTON.

STATEMENT OF DR. JOHN P. HAGEN, DIRECTOR OF THE VANGUARD PROJECT, NAVAL RESEARCH LABORATORY—Resumed

Mr. FULTON. Do you believe the proposed nuclear tests to take place in the Pacific within the next few months are necessary and vital to our United States security?

Dr. HAGEN. The matter of the nuclear tests is somewhat outside of my present experience in Vanguard. However, there are certain aspects of these tests that I believe are essential to our national security.

Mr. FULTON. And in your judgment, then, anything that advances nuclear theory, advances both the peacetime as well as the warlike purposes and, therefore, it will bring us that much nearer to nuclear propellants for outer space vehicles, will it not?

Dr. HAGEN. Yes, work in the nuclear area is bound to contribute in the long run to nuclear propellants and nuclear propellants are something that we sorely need in the rocket field.

Mr. FULTON. In your firm judgment as a scientist, you would agree with President Eisenhower that the nuclear tests in the Pacific should be proceeded with even over Russia's objection and the objection of the British Labor Party?

Dr. HAGEN. Within the limits of my experience, yes.

Mr. FULTON. We have in the air now on behalf of the United States a security force. In your judgment as a scientist, are the B-52 bombers that we have in the air necessary parts of our strategic defense because of the fact that the missile and the satellite programs are not far enough advanced from their infancy yet?

Dr. HAGEN. I think that is certainly correct; that we must be in a position to defend ourselves with whatever we have at hand until we reach the ideal.

Mr. FULTON. So that the programs of space that we are working on do not mean and should not mean the cutting of our present security measures by the Armed Forces nor by the Air Force?

Dr. HAGEN. Certainly not.

Mr. FULTON. You would, therefore, have this program in addition to any other military programs for the protection of the country?

Dr. HAGEN. I think that is correct. In time all things change and the time may come when we will put more emphasis on missiles and satellites and the like and less on conventional aircraft, but that time is not here.

Mr. FULTON. Admiral Rickover said when he was before the committee last Friday that if he had been under the Atomic Energy Commission rather than under the supervision of the Navy, he could have gotten the nuclear submarine going "a damn sight faster."

Do you have any comments on the Navy's supervision of your project or do you disagree with Admiral Rickover?

Dr. HAGEN. I do not disagree with Admiral Rickover. In terms of the project that I have carried on, however, I would not direct the criticism specifically at the Navy. I would say that had we wanted to bring this project to fruition at the very earliest date, then the overall method of approach should have been different in the beginning and the lines of communication about the project should have been shortened. There should have been fewer committees and executives to whom you refer.

Mr. FULTON. How many echelons or layers of authority do you have to go through before you could get a firm decision on major policy matters in your agency?

Dr. HAGEN. On the very major ones, about five.

Mr. FULTON. Various levels of decision?

Dr. HAGEN. Yes.

Mr. FULTON. At this point in the record, with the chairman's permission, I would like a chart of the various authorities for decisions on the Vanguard program put into the record.

The CHAIRMAN. Without objection, it is so ordered.

Is it available?

Mr. FULTON. I think you can make them up showing where you went for decisions and how they were made and give us a history of it, if you will, at the various stages.

(The material referred to follows:)

PROJECT VANGUARD

LEVELS OF MANAGEMENT DECISION MAKING AND REVIEW

The following chart illustrates examples of major management decisions or decision areas in the column on the left The several levels to which proposed decisions must be referred for approval are shown to the right. Within the United States Naval Research Laboratory two approval levels exist, (1) the NRL Director of Research, who manages the entire Naval Research Laboratory research program (a civilian scientist) and, (2) the Director of the Laboratory (a Navy captain) who is of course responsible for the overall Laboratory program and operation. The Vanguard effort uses an average of one-tenth of total Laboratory effort in terms of manpower.

There are two levels of review in the Navy Department. The Chief of Naval Research is assigned overall management responsibility for Project Vanguard by the Secretary of Defense through the Secretary of the Navy.

The Office of the Secretary of Defense exercises two major functions in the direction of the program One is the review of the technical program which includes approval of requests for required facilities, use of other military service facilities, and approval or denial of insurance or backup efforts in the project. The second function is review of program budget including direction of the funding process and release of available funds.

The USNC-IGY is the United States National Committee for the International Geophysical Year, an instrumentation of the National Academy of Science, the latter being a quasi-Government agency set up by act of Congress to advise the President in scientific and related matters. The National Science Foundation is the Government agency which as one of its functions acts as executive agent for the National Academy of Sciences in the conduct of substantive programs such as the IGY. This administrative complex is concerned with the content of the scientific experiments in the Vanguard satellites (as well as the Army-IGY satellites) and coordinates the whole effort as an aspect of the International Geophysical Year. The only funds appropriated directly by the Congress for the USNC-International Geophysical Year satellite program prior to January 1958 was a supplemental 1956 appropriation to the National Science Foundation of about $27 million which included slightly less than $19 million for the Vanguard-IGY satellites. Roughly two-thirds of the latter amount was allocated to the Navy's Project Vanguard at the Naval Research Laboratory for satellite scientific

instrumentation and satellite tracking and data analysis. The other one-third finances the optical tracking program conducted by the Smithsonian Astrophysical Laboratory and for other Academy-Foundation program costs.

Project Vanguard authorities for decisions

Examples of decisions	Decision makers									
	Naval Research Laboratory			Navy Department		Department of Defense				
	Director of Vanguard	Director of Research	Director of Naval Research Laboratory	Chief of Naval Research	Secretary of Navy	ARPA (former Director of Missiles)	Comptroller	USNC-IGY (National Academy of Science-National Science Foundation	The President	Congress
Technical:										
Within scope of project	X									
Decision to modify tracking	X	X	X			X		X		
Changes in science program	X	X	X					X		
Changes in vehicles-design, etc	X	X	X			X				
Schedule	X	X	X	X	X	X				
Contracts, initiating change orders	X	X	X	X						
Procurement:										
Under $5,000 each	X									
Over $5,000	X	X	X							
Budget:										
Internal operating	X	X	X	X						
Overall program	X	X	X	X	X	X	X		X	X
Science program	X	X	X	X	X			X	X	X
Funding:										
Total project	X	X	X	X	X		X		X	
Science program	X	X	X	X	X		X	X	X	
Personnel										
Ceiling alowance	X	X	X	X	X					
Hiring	X	X	X							
Promotion	X	(X)	(X)							
Organization of project	X	X	X							

Mr. FULTON. Do you believe the speed of light is the absolute speed that can be reached, or are you one of the physicists that believe there is a variable speed and we would exceed it if we had one kind of energy we do not know about now?

Dr. HAGEN. No, sir. So far as I am concerned the speed of light does represent an absolute limiting speed to which we can bring matter, for example, the theory of relativity which now is well founded shows that the mass of a particle increases with the speed. This necessarily means it is not possible to accelerate that particle beyond the speed of light.

Mr. FULTON. When you get two galaxies that are moving apart, each at the speed of light, then to each other they are relatively moving twice as fast as the speed of light?

Dr. HAGEN. If they were moving apart at this rate, then they could not see each other.

Mr. FULTON. No; but relative to each other they are moving at a rate where the distance is increasing at twice the speed of light. So that if you take a fixed focal point, are you not right? But if you take a moving focal point you are not right?

If the speed of light is the way we see stars there could be stars that we do not even see because they are going away from us faster than the speed of light. We would never see them.

Dr. HAGEN. If it were possible that a star were receding at a greater velocity than the speed of light?

Mr. FULTON. Just at the speed of light.

Dr. HAGEN. Then we may never see them.

Mr. FULTON. Then the blank spaces in the heavens might be filled with stars also?

Dr. HAGEN. I don't think so. I think the theory shows that it is physically impossible for two objects to be moving away from each other at a speed greater than the speed of light.

This sounds contradictory to what was said earlier, but I believe the key to the explanation lies in the interpretation of time.

Mr. FULTON. Let me have one final question. It was given to me on a Navy examination here to see if I should be promoted from a Navy Reserve Lieutenant. I should like some authoritative advice: Thrust means, of course, the push forward; drag means to hold back; lift means the rise upward, force upward; and gravity means the pull downward.

What is a Vanguard rocket doing when the thrust equals the drag and when the lift equals the gravity?

Dr. HAGEN. If the thrust equals drag——

Mr. FULTON. And the lift equals gravity, what is the Vanguard rocket doing?

Dr. HAGEN. It is not doing very well; no, sir. If the thrust equaled drag there would be no net forward force.

Mr. FULTON. I am asking you. I made an answer that I thought this particular Vanguard was in constant, not accelerated forward flight, without power; it gets right to the stall point in the arc.

Do you know of a time when there is no thrust forward?

Dr. HAGEN. Only after the engines have ceased burning. The way the Vanguard is operated is that for the first, about 4 minutes, the first 2 engines burn, assert their thrust. The thrust is always greater than the weight of the vehicle.

Mr. FULTON. That is two g's. Now, suppose it just equals gravity at a certain point.

Dr. HAGEN. There would be an acceleration so long as there is any thrust at all, but the thing to remember is that by the time the thrust has fallen to the point where it is equal to gravity or less, the vehicle is near the end of its burning and it is at a high velocity.

Mr. FULTON. Will you insert that in the record when you are finished?

The CHAIRMAN. All the witnesses will be able to edit their testimony. You have permission to elaborate on that.

(Material is as follows:)

The acceleration of a rocket results from the net force acting on it. This net force is the difference between the forward thrust exerted by the engine, and the retarding forces of gravity and air drag. At takeoff, of course, and there is no drag, so the net lift or upward accelerating force is just the engine thrust, in Vanguard's case 27,000 pounds, minus the vehicle's weight, 22,000 pounds, or roughly 5,000 pounds. Thus the initial acceleration at takeoff is fairly low.

In flight, the air drag increases with speed until the rocket reaches high altitudes where the effect of the very thin atmosphere becomes negligible. The

weight of the rocket, however, decreases very rapidly as the propellents are used up. Since the drag is never very great and the engine thrust is nearly constant, this decrease in weight results in a higher and higher acceleration. Near the end of burning the rocket is virtually an empty shell and is under tremendous acceleration; of course there is still the deadweight of the remaining stages, but the acceleration is great enough to bring the entire vehicle up to a very high volicity in those last few seconds. At all times during the burning, the thrust of the rocket far exceeds the combined forces of weight and drag; if it were not so, the rocket would slow down instead of accelerating.

The process continues when the second stage take over. By this time the direction of flight is turning toward the horizontal. At the end of second-stage burning, the rocket has received enough upward momentum to coast the rest of the way up to orbital altitude in spite of the slight drag and the pull of gravity, just as a stone hurled upward will coast to a certain height.

At orbital height the third stage is fired, ideally in a perfectly horizontal direction In this case there is no upward force and the third-stage thrust is used entirely in giving the satellite a sufficient horizontal velocity to keep it in orbit; the spent second stage, of course, falls into the sea. The drag at this altitude is negligible so far as the third-stage rocket is concerned, even though it is sufficient over a long period to slow down the satellite.

To recap, then, the thrust of the rocket always greatly exceeds the drag and, even at takeoff, considerably exceeds the force of gravity. In the coasting period after the end of second-stage burning, there is no thrust so both gravity and the very slight drag of the residual atmosphere act to slow the rocket's motion. At all other times the rocket is under positive acceleration.

Mr. FULTON. Could I ask this request of the chairman? I have asked the various scientists who have appeared before us to give their definition of scientific terms and words they have used in their own testimony and in their statements.

Secondly, I would like a definition that is universally agreed on, adopted for this lingo that we are getting into so that the committee in its report can put out an authoritative definitive statement of some of these words.

Mr. FELDMAN. We are working on a glossary of terms.

Mr. McDONOUGH. This glossary of terms is already published in the last edition of Space Magazine.

Mr. FULTON. Just by the Air Force. I would like one that is a legal glossary for legislative use and adopt it as the overall terminology for both the legislative department, the executive as well as the services.

I should like an official glossary brought up by agreement of the scientists because in some places this morning even you were using the terms interchangeably, air, atmosphere and space.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. Dr. Hagen, I know that I voice the sentiments of all members of this committee and all members of Congress in expressing our admiration for the devoted work that you have given in your field.

When Vanguard got up, we were delighted for many reasons, one of them being because of Dr. Hagen and the hard work he had put into it.

You know as well as I do that to many people in this country the previous attempts to get Vanguard up were looked upon as complete failures.

Now, that is not accurate, is it?

Dr. HAGEN. No; it is not accurate. They were test vehicles and the history of rocketry clearly demonstrates that one should anticipate a certain number of mishaps in any program. It was unfortunate that we had our mishaps at the very time we did have them. How-

ever, we did learn many things from these so-called failures that taught us to perfect a usable and successful vehicle.

I think this is a good opportunity for me to point out that even though today we now have a vehicle which demonstratively can put a satellite in an orbit, it would be very foolhardy for me to presume that all succeeding vehicles will be successful. We are bound to have other flights which do not put a satellite in orbit.

Mr. KEATING. Is there any doubt in your mind, Dr. Hagen, that the Russians have had many failures in getting a satellite into orbit?

Dr. HAGEN. There is no doubt in my mind at all. I would be hard put to prove that fact, but there is no doubt in my mind that that has gone on.

Mr. KEATING. That does not lend itself to capability of positive proof very easily, does it?

Dr. HAGEN. No; it does not. It requires the cooperation of the Russians in what they consider a sensitive area.

Mr. KEATING. It is not like atomic tests in that regard?

Dr. HAGEN. That is correct.

Mr. KEATING. But you are confident that there have been failures?

Dr. HAGEN. Yes.

Mr. KEATING. And are confident they have had as many as we have had?

Dr. HAGEN. At least as many.

Mr. KEATING. In that connection, you have spoken of 5 or 6 that you have launched to date.

Dr. HAGEN. We have launched six to date. Of these 6, the first 4 were test vehicles which were not complete vehicles and were not intended to have the full capability of putting a satellite in an orbit. These first four were uniformly successful. The next two vehicles we called failures. Those two did have the capability of launching satellites.

Mr. KEATING. Which were the ones that actually got in orbit?

Dr. HAGEN. No. Six. The sixth vehicle we launched. In other words, we have had four successes and two failures in our launchings. Of these 4 successes, 1 of them was so designed that it could put a satellite in an orbit.

Mr. KEATING. Now, your plan is eight more.

Dr. HAGEN. We have now eight more vehicles with which we will attempt to launch the IGY satellites; yes, sir.

The CHAIRMAN. Eight more vehicles? To do what?

Dr. HAGEN. To launch the IGY satellites.

The CHAIRMAN. Eight separate ones before the final launching of the big one?

Dr. HAGEN. No, I should clarify that.

There are five experiments to be done in the Vanguard program in the IGY. An X-ray, an ultraviolet, and a geomagnetic experiment, and two experiments on the weather. Those 5 experiments are assigned to 8 vehicles allowing us alternate vehicles in case of failure in 1 or 2 cases. In that 8-vehicle program, then we will attempt to put up 5 IGY experiments.

The CHAIRMAN. One in the very near future?

Dr. HAGEN. One in the very near future, and that one will measure X-ray radiation from the sun.

Mr. McDonough. If you had 5 successes in a row, get up your 5 different kinds of equipment, you might not go to your 8th?

Dr. Hagen. I think we would. If the impossible happened and we got the first 5 in a row, then we would scurry about and put up 3 more experiments for the IGY.

Mr. McDonough. Are those intended all to be done this year?

Dr. Hagen. Yes, sir; they are planned to go before the end of this calendar year.

Mr. McDonough. In that connection you made this statement this morning—and if I tread on the grounds of security you set me straight—that our chief competitor, and I assume you mean Russia, has a plan similar to our plan.

Are you at liberty to tell us what that plan is?

Dr. Hagen. I really am not at liberty to discuss that to any greater extent than I did earlier.

Mr. McDonough. That puts me in mind of this, which I have wanted to ask someone in authority on the matter of security. This time table of the services, except as they themselves release it, is considered a matter of security, is it not?

Dr. Hagen. Yes, sir. Our schedules are kept classified, but, of course, the point here is that in all of this missile work, eventually your laboratory becomes the proving ground and once you go to the proving ground it is virtually impossible to keep your everyday actions secret. They are open to inspection by the workers at the proving ground and by the press who can stay on the beaches and look up and see what is on the stand. So once the project gets to the point where you go to the proving ground to begin launching attempts, as soon as your missile is erected it is quickly deduced what your schedule is.

Mr. McDonough. The precise time of launching is not known, is it?

Dr. Hagen. No, sir it is not. It has always been our policy in Vanguard not to announce the precise time of launching until after the fact.

Mr. McDonough. Do I not understand that at Canaveral they have now made a gentleman's agreement with the press to tell them in advance of the date of launching under some honor system whereby they do not reveal it?

Dr. Hagen. This is my understanding. I have never been privy to the thing, but it is my understanding that such an agreement did at least exist a few months ago. Whether it is presently in existence, I cannot testify.

Mr. McDonough. I am asking some of these questions for personal guidance. I was down there and was given quite a little information about the plans. I would not have dreamed about saying anything about specific dates or anything of that kind.

I wondered whether I was being unduly cautious in that regard. That is a correct procedure to follow, is it not?

Dr. Hagen. Sir, if I knew the date of any firing down at Canaveral, I would do the same thing: I would be quiet about it.

Mr. McDonough. Now, I want to ask you this: You are taking readings from these scientific instruments which are in Vanguard and you were getting readings from sputnik that was up there. Have you gotten more and better reports from the United States satellites than you ever obtained from sputniks.

Dr. HAGEN. Yes, sir; we have, and for this reason: That we understand, know the experiment that is in each of the United States satellites and we therefore can derive a great deal more information from the results that are sent back.

This touches on a point that was raised earlier this morning that I probably should clarify just a bit, and that is this: The exchange of information that is planned as part of the International Geophysical Year does not encompass any exchange of classified information. That is, we have never revealed to the Russians information which we consider classified. In their visits here they have been exposed only to the unclassified portions of the work. We anticipate and expect that when the Russians get to the point where they have analyzed the data out of their two satellites that they will forward the information to the exchange mechanism and we then will be able to evaluate more properly just what they accomplished.

Mr. McDONOUGH. Is it your judgment that your equipment is superior to theirs in efficacy and that you are getting more and better information than they were able to get from theirs?

Dr. HAGEN. I like to believe that is true. I can state it only as a belief. At present we will have to wait until the end of IGY to make that evaluation.

Mr. McDONOUGH. But that is your belief at the present time?

Dr. HAGEN. It is my belief; yes, sir.

Mr. McDONOUGH. Now, when the Russians were here in late August in conference with you, you were involved in many of those conferences, yourself, were you not?

Dr. HAGEN. Yes, sir.

Mr. McDONOUGH. Did they say anything about the fact that the next month they were going to put sputnik up?

Dr. HAGEN. No, sir; they didn't, and even on the morning of the day that the first of them went up they just did not, in response to questions, answer as to when they might be ready to go.

Mr. McDONOUGH. They were still here that morning?

Dr. HAGEN. Yes, sir; they were still here, and in a meeting at the National Academy of Science Building on Constitution Avenue, they were asked this question. My remembrance of the answer was, well, they cannot say when they would go, but we would have plenty of time to change the frequencies in our radio observations, the point being that they did not use the agreed radio frequency for the beacon transmitter and we were quizzing them about that. It meant that we had to make wide changes in our stations. Their answer that morning was that we would have plenty of time to make this change.

Mr. McDONOUGH. You had agreed in setting up the plans for the Geophysical Year, you had agreed on the frequency that would be used?

Dr. HAGEN. 108 megacycles.

Mr. McDONOUGH. The Russians were party to that agreement?

Dr. HAGEN. Yes, and it was a year later at the Washington conference that they then told us thay did not intend to use 108, but they were going to use 20 and 40 megacycles.

Mr. McDONOUGH. How much ahead of putting sputnik up?

Dr. HAGEN. A few days. This was just prior to October the 4th when Sputnik I went up.

(EDITOR'S NOTE: The U. S. S. R. published in the June 1957 issue of Radio (in Russian) its intention to use 20 and 40 megacycles.)

Mr. McDonough. How can you deal with anybody that acts that way? What should we do in this situation?

Dr. Hagen. I think, at least I like to hope, that by playing the game very straight, by being careful about the information we divulge, we can, at least with their scientific people, build up a sufficient confidence so we can get an equitable exchange of information.

The Chairman. In other words, you do not think we should react to them?

Dr. Hagen. I think it would be too bad if we did.

The Chairman. You would take the affirmative side and make all disclosures possible consistent with the spirit of the IGY and consistent with our national interest?

Dr. Hagen. Yes, sir; I believe that is true.

The Chairman. I would feel unreservedly the same way. We cannot keep reacting. We have our side of the road and there are other nations and other scientists involved, and the most possible frankness has beneficial results.

Dr. Hagen. I think it does.

Mr. McDonough. Lest I be misunderstood, I agree with the statement of the chairman, but I know he would agree with me if you are sitting around a poker table and you are showing your cards you do not show your own unless the others show theirs.

The Chairman. When you get into poker, why——

Mr. McDonough. I would not imply that the chairman was ever in a poker game, but I am concerned as I am sure the chairman is, about the fact that we were somewhat misled.

Now, we should be very much on our guard not to let it happen again.

Dr. Hagen. Yes, and I believe you can be assured that necessary controls are there so that this cannot happen. All of the information is not going to be delivered in one fell swoop. It is going to be put down in bits and pieces and it soon will be clear whether we are in an even-Steven game or not. If we are not, then we should do something about it.

Mr. McDonough. Since they did not inform us of the frequency of the first satellite they put up, did they inform us of the frequency that they were going to use on the largest one they put up, the 1,100 pound one?

Dr. Hagen. I am not certain whether they did or not. It happened to be the same frequency so we detected it immediately. I am not sure whether we had information from them as to its frequency.

Mr. McDonough. Could we interpret anything from it, the electrical impulses we obtained from it?

Dr. Hagen. We learned a lot through observing that satellite. We at NRL observed it with radio and Dr. Whipple and his people observed it optically.

From these observations we were able to arrive at a new estimate of the density of the air at a height of about 130 miles. This was a very new and useful piece of information. How much of the remainder of the information that was radioed out of those satellites that may have been learned, I am not prepared to, or able to talk about.

Mr. Brooks. I merely want to ask this question: Since we now have three satellites up and Russia has none, do you notice any more interest on the part of the Soviets to reciprocate with information?

Dr. HAGEN. I have not detected it; no sir.

Mr. BROOKS. They have shown no change?

Thank you.

Mr. FULTON. Will the gentleman yield?

Mr. KEATING. Yes, I will yield again.

Mr. FULTON. In the sum total of exchange among scientists in the United States and Russia, how would you calculate whether we in the United States have gotten a fair return of information during these conferences? You must remember that the State Department, just about this time, is preventing a piano player and violin player from coming into the city of Pittsburgh to play because of security reasons, or let them go to Cleveland or New York.

Dr. HAGEN. I believe that if you wish to discuss this point in its full detail, you would have to consider the whole of the IGY and that should be referred to the National Academy.

Mr. FULTON. Will you put in the record a statement on that, please?

Dr. HAGEN. Yes.

(The material referred to is as follows:)

It is always wise to meet with scientists from other countries in conference. The planned exchange is that of information concerning scientific experiments, plans for future work, and a discussion of the theoretical interpretation of observations. The more important exchange does not appear on the agenda: it is the opportunity afforded the participants to observe those from other countries and thereby derive information concerning their training and their knowledge of subject matter, and to do some "fishing" of the status of scientific effort in other countries. If ever there is an opportunity to increase the understanding between peoples it is here. I believe we must and do obtain a fair return of information in our exchanges with the Russians since we talk about things which have been openly discussed in this country whereas they, owing to their more secretive policies, must talk about things Russian which have not been so freely published. In the present situation conferences are to be encouraged since we stand to gain much more than we lose.

Mr. KEATING. I believe you said that we have not yet worked out a definite method of bringing a satellite back to earth.

Dr. HAGEN. Yes, sir. The point here that really needs to be clarified is this: If we decided that we wish to bring one of our own satellites back to earth, then we could design it for that purpose and put in it a small rocket, for example, which on a signal from the earth could slow it down in its course and then by other means, say parachutes or balloons, we could recover it.

In that way we could effectively remove that satellite from an orbit and get it back to the surface of the earth. But if we are dealing with a satellite that has been not prepared in this fashion, or if we are dealing with a satellite over which we have no control, at the present time there is very little that we can do except to destroy it as an entity, to break it up into parts.

Mr. KEATING. While it is still in space?

Dr. HAGEN. While it is still in space, but those parts would still keep on in that orbit.

Mr. KEATING. The other method we have not definitely worked out yet, of bringing the satellite back?

Dr. HAGEN. This has not yet been demonstrated in fact.

Mr. KEATING. It is in the theoretical stage, or perhaps the development stage, but has not actually been tested?

Dr. HAGEN. That is correct.

Mr. Keating. As I understand it, when one of these satellites stops going around and starts back because it has a pull on it, it has had enough pull on it that it starts to come back, like Sputnik No. 2 just did; is that apt to burn up by friction?

Dr. Hagen. It is going to get hot. Now, Professor Whipple is an authority on meteors and he can tell you much more about this than I can, but as the satellite loses energy owing to the drag of the atmosphere, its orbit will shrink. The anomalous thing is that as it loses energy due to the shrinking of the orbit, the falling back toward the earth, it gains speed. It comes into the atmosphere at a speed that is nearly as great as the speed of a meteor and aerodynamic heating occurs. The satellite will get very hot and if it is a lightly constructed affair such as our satellites, we expect that it will disintegrate on coming into the air. If, however, it is a massive piece of metal, as Sputnik No. 2 was, then it is probably too heavy to disintegrate completely and will come right into the surface of the earth.

Mr. Keating. It will come into the surface of the earth as an entity and if somebody is standing there it will kill them?

Dr. Hagen. It certainly would.

Mr. Keating. Now, do we have any knowledge about Sputnik No. 2 that is not classified as to where it landed and in what condition it was?

Dr. Hagen. We think that we know it came down in the Caribbean and then probably landed in the water.

Mr. Keating. Was it in flames?

Dr. Hagen. It was seen as a bright object going through the sky and little bits of material were coming from the thing as it went by. Professor Whipple just said to me that he believes it did not actually go into the water in the Caribbean, but got around the world still further.

Mr. Keating. Before it hit the water?

Dr. Hagen. Before it hit the water or land

Mr. Keating. Maybe I am asking questions that I should not, but I am curious to know where the thing landed.

Dr. Hagen. Well, I think we all are, and that was true also of the first sputnik that came down. The point here is that such a large part of the earth's surface is uninhabited, or is covered with water, that it is highly unlikely that any of these satellites will ever come down where man can see it land.

Mr. Keating. Well, it depends on how many come down, does it not? It is true 70 percent of the earth's surface is water.

Dr. Hagen. Some large percentage. I didn't think it was as high as 70 percent.

Mr. Keating. Now, that would mean that 1 out of 4 of these might land on land under normal circumstance, or could?

Dr. Hagen. There are large land areas that are uninhabited, too.

Mr. Keating. That is true, but we were talking this morning about the menace of these things. It looks to me as if one of the menaces is the danger of their not disintegrating in the air and falling and doing damage to persons or property where they fell.

Dr. Hagen. I think that certainly is a menace, but the probability that that would happen, that it would fall and either damage manmade property or damage an individual, is very, very small.

Mr. KEATING. Later in these hearings we are going to have some testimony about who is liable if one of these things comes down and hits the chairman of this committee or somebody.

Now, you do not have any particular views on that as a space lawyer, do you?

Dr. HAGEN. No, sir; I do not pretend to be a space lawyer, but I would certainly feel that the man who puts the satellite in the air is the man who is responsible for its actions thereafter.

Mr. KEATING. Or the government, if it is a governmental project?

Dr. HAGEN. Yes.

Mr. KEATING. There is another thing about your testimony that was a little confusing to me. It is still confusing to me, but all you have to tell me is that it is not anything for a public hearing:

Do we know where Sputniks Nos. 1 and 2 came down, or is it still a mystery?

Dr. HAGEN. I don't believe we know exactly where.

The CHAIRMAN. Do you think anybody else knows?

Dr. HAGEN. I am not so sure about Sputnik No. 2, but about No. 1, I don't believe anybody really knows.

Mr. KEATING. Do we know whether No. 1 actually disintegrated before it hit the surface of the earth?

Dr. HAGEN. There is some evidence that it did, but we do not know this for sure.

Mr. KEATING. You talk about advanced Vanguard, as I think you mentioned the project. I think you said, and you set me straight on this, that you could now put 75 pounds in orbit?

Dr. HAGEN. No; I did not say we could do it now. Let me review what I should have said, let us put it this way: The improved Vanguard which should be in being later this year will be capable of putting some 40 pounds in orbit. The next step beyond that would be the step where we could put some two or three hundred pounds in an orbit. Using the Vanguard vehicle with known and in-hand pieces of hardware, just using other combinations, it is possible to put as much as about 900 or 1,000 pounds into a satellite orbit.

Mr. KEATING. When could you do that if you had some funds?

Dr. HAGEN. This would take another year or two.

Mr. KEATING. If you had the funds and were given complete support and you were given the project of putting a man into space—I recognize your reluctance about doing that now, but suppose it were decided to do it. Apparently there are a lot of volunteers getting ready to do it, and getting this man back alive, and, of course, we would not put anybody into space unless we thought we would get them back alive. How long would you want for this project?

Dr. HAGEN. This would involve, too, surely that the man do some useful thing while he is up there?

Mr. KEATING. He had better be of some use to get him up there and alive, had he not?

Dr. HAGEN. Yes. I think it gets very problematical as to what the time would be, but we would be in a position hardwarewise to do this in another 2 or 3 years. It is something that one would wait at least that long for. The hardware is going to be available before that time, but it will take time to bring it together and to take the necessary precautions in the design of the capsule in which the man rides, in order to bring him safely back into the atmosphere.

Mr. KEATING. Now I do not want to accentuate any interservice rivalry, but we have had testimony, I think, from Dr. von Braun that if he had that "go" sign tomorrow he could do it within a year.

Dr. HAGEN. Perhaps he would. I think one should be very careful in defining his terms in giving an estimate like this. That is why I asked the question like that. I would want to qualify it by saying that a man would be put up in a vehicle so that he could do useful work. The other thing is that a man could be safely recovered.

The CHAIRMAN. I think Dr. von Braun said something about 160 miles in space, staying up there a few minutes.

Dr. HAGEN. That is a different thing altogether. He was talking simply of a rocket shot, in which the man is shot up in the air and brought back down. I was talking in terms of a satellite in which a man would make at least one circle around the earth.

Mr. KEATING. And that equipment be so designed so as to be able to talk about?

Mr. HAGEN. Yes.

Mr. KEATING. I think that is correct.

Now, can you do the other job in a year, or do you think that is a little too optimistic?

Dr. HAGEN. I am not so sure. I would think it might be a bit optimistic.

Mr. KEATING. Now, I respect your views, Dr. Hagen, and these questions are not intended to be critical of your views, but do you belong to the school of thought which believes we should not try to put a man up there and bring him back until we can put him to some useful job?

Dr. HAGEN. Yes, sir. I think this is so. I believe that the order in which we should do things is this: that we should not use the man as a guinea pig. We have other ways of doing it.

The aeromedical people have plans that will allow us to measure all of the critical areas and items ahead of time so that we will know all of the things that we need to know about the survival of man in a space vehicle. We should learn those things without jeopardizing the life of an individual. Once we have learned them, then we should prepare to put a man up there to serve a useful purpose.

Mr. KEATING. I want to ask you one other question, which again may border on security. It has to do with fuels.

Do we know the type of fuels which the Russians are using?

Dr. HAGEN. No. I don't think we know as a fact what the fuels are. As I pointed out earlier, they could be using essentially the same chemical fuels that we are.

Mr. KEATING. In your judgment are they?

Dr. HAGEN. I believe they probably are, although I am also sure they are experimenting with more exotic, higher energy fuels.

Mr. KEATING. I have heard of that word "exotic" time and time again in this reference. Does that mean a higher energy fuel?

Dr. HAGEN. No, sir; I believe the meaning of that word is that it is foreign or strange, and it has been used a lot because the use of the higher energy fuels is foreign to our experience.

The CHAIRMAN. Are there any further questions?

Mr. KEATING. Yes, just a couple more, Mr. Chairman.

You referred to the fact that your top men, five of them I think, had a salary of around $12,000 a year.

Dr. HAGEN. Yes.

Mr. KEATING. Dr. von Braun testified here that his own salary was $19,000. He seemed to show no reluctance in testifying to that. He has this group around him down there, who are under civil service, as I understand it. Yet their salary scale, I have the impression, is higher than yours.

This $12,000 is not the top which scientists could draw under your program, is it?

Dr. HAGEN. Almost. That is, if they wanted to follow the policy of not having the man earn more than the man for whom he works, $12,000 would be pretty nearly the ceiling.

Mr. KEATING. Do they not follow that policy in the Army?

Dr. HAGEN. It sounds as though they have classified some of the positions at a higher level than our positions have been classified.

Mr. KEATING. I want to ask you a word or two about this bill, about which you have testified.

You have expressed preference for a small Board, perhaps a 5-man Board full time, as against this 17-man Board, part time.

Another possible approach here is to have this larger Board, but to make their duties purely advisory.

In other words, this bill, as it has been introduced, makes the 17-man Board the overriding authority above the Director as to certain very fundamental things. I recognize the unwieldy character of that. Now, if you shifted that so that they were advisory only, then you could have a more centralized authority in one man, the Director, without the intervening 5-man Commission, could you not?

Dr. HAGEN. Yes, sir; that is true.

The way it is written it says:

The Board shall be consulted by the Director.

Now, the meaning of these words is not clear to me. The Director could consult the Board, but then ignore their advice, I believe.

Mr. KEATING. I suppose.

Dr. HAGEN. I do not know how one would interpret those words. The interpretation, the restrictive interpretation that I would put on them, is that the Director should consult the Board and abide by their recommendations.

Mr. KEATING. Otherwise, as to these very fundamental and far-reaching matters, it is rather meaningless if the Director is going to have complete carte blanche to do everything he wants to do after he is consulted.

Dr. HAGEN. Yes.

Mr. KEATING. As between plan A whereby you have an advisory 17-man or large Board, plus an operating Director, or, B, a plan for a 5-man operating group with a Chairman who is Director, which of those 2 plans do you like better?

Dr. HAGEN. I prefer the smaller group and would expect that the smaller group would be composed of full-time people. I should probably go back to the discussion this morning and I do believe that I probably confused the issue a little bit by suggesting that they might perform other functions.

Let me state this: I believe that this group should have as its function solely the determination of the policy that the agency is to follow and that the group would determine that policy.

The Director who would be the chairman would be the executive chairman of the group.

Mr. KEATING. I see, because under section 6, subsection 3, there are very extensive operating authorities given to this agency. Your idea is that the Director would be the one who would be responsible for the operation and the Commission or Board of, say, five men, simply for policy problems.

Dr. HAGEN. Yes.

Mr. KEATING. Now, in the Atomic Energy Commission, are not all the members jointly responsible for operating as well as policy?

Dr. HAGEN. I am sorry to say that I do not know.

Mr. KEATING. I think that is something for this committee to look into because that has been quite a successful method of operation and it may be that we should pattern this more after that than in the way we have it here now.

Since you favor a department of science and technology or technical man in the Cabinet, if you did not have that, and perhaps we are not ready to take that step yet, you would share my view, would you not, that the Director of this Agency have the equivalent of Cabinet status in that he would sit with the National Security Council and in Cabinet meetings and have a voice in the formulation of policy at the very highest level.

Dr. HAGEN. Yes, sir; I believe this would be necessary, at least as far as the Security Council is concerned.

Mr. KEATING. Do you think that we should incorporate in this legislation to effectuate that, or should we leave it to Executive action?

Dr. HAGEN. I do not believe I am competent to discuss that point.

Mr. KEATING. That is all I have, Mr. Chairman.

Dr. HAGEN. May I say one other thing. In answering the questions here, because of the urgency of the job that I know this committee has, I have not held back any of the answers. All of the answers, however, should be considered to be my personal opinion and not to express the attitude or the opinion of the Department of Defense.

The CHAIRMAN. That is understood.

Mr. Ford?

Mr. FORD. Dr. Hagen, when you were given the job as Director of Project Vanguard, did you feel at that time it was a sound and feasible project for the stated purposes?

Dr. HAGEN. Yes, sir. If I had not felt at that time that it was sound and feasible, I would not have taken the position.

Mr. FORD. I have always been impressed with your testimony, when you and others from Dr. Bennett's office have been over to testify as to your expenditures, with the fact that you never made statements that seemed to be tooting your own horn, so to speak, forecasting success, as might easily have been the case.

I was looking through the testimony of the last 2 years this morning on the appropriation requests and never once were you categorical in your statement, that it would be successful within the IGY.

It has been very successful and I want to compliment you on the accomplishment that you have made to date and which I am sure you will have prior to the end of the IGY.

Are you going to be able to do this job with the $120 million that was made available?

Dr. HAGEN. It is not quite $120 million. I hope we will be able to do the job with the funds in hand. The project is funded up to $110 million, plus another small amount, less than $2 million, for tracking. Now, it does appear that except for some unforeseen calamity we will be able to finish the job with what we have in hand.

Mr. FORD. Doing the job with the funds allocated is an achievement in itself, I might say.

Dr. HAGEN. I hope we can bring it about.

Mr. FORD. Would it be your recommendation that at the conclusion of Project Vanguard you will recommend an extension of Project Vanguard or should we put emphasis on the other Department of Defense projects in this area?

Dr. HAGEN. Sir, I believe this: In Project Vanguard, we have necessarily built up a facility for doing a particular kind of work which is an asset as far as the Department of Defense and the country are concerned. It it a group of people tailormade to do a specific kind of job. I believe that it would be just a waste of our national assets to allow this group to dissipate and then have to start all over again with another. For that reason, I hope that in the plans for the future space research there will be a place for Project Vanguard and that there will be an extension of the kind of thing we have started.

Mr. FORD. Project Vanguard is a nonmilitary operation?

Dr. HAGEN. Yes, sir; even though it is in the Department of Defense.

Mr. FORD. It would seem that if this new Agency is set up, then the organization to which you refer would be a natural starting point within this new Agency for its overall work in the area of space and so forth?

Dr. HAGEN. Yes, sir; it could be. That will depend a great deal upon the method of operation chosen by the Agency. As I see it, they could go into a department and absorb unto themselves those parts, or those functions they can most properly use to build up their organization, and as I read the bill the authority to do that is written into the bill.

That is one way of operating. Another way would be for the Agency to administratively take over the group, for example, the Vanguard group, but allow it to function in its present location. Now, this may be the only way that Vanguard per se could continue in doing this kind of work.

Mr. FORD. I suspect you have had your hands full trying to make this project work?

Dr. HAGEN. Yes, sir.

Mr. FORD. Have you or your people had an opportunity over and above that very great responsibility to think of a logical follow-up of Project Vanguard?

Dr. HAGEN. Yes, we have. I personally have spent a good deal of my effort and energies doing just this. We have presented from time to time a forward-looking program that goes beyond Vanguard, that is hinged on the fundamental notion that this vehicle was so designed that it not only would be a most efficient vehicle to put a satellite in orbit, but would be sufficiently flexible to permit change and improvement. So the programs that we have recommended have been based

on improvement of the Vanguard vehicle to give it the capability of handling bigger things or going greater distances.

Mr. FORD. Do those recommendations go to ARPA at the present time?

Dr. HAGEN. At the present time, yes; they would go to ARPA. They did, antedate ARPA, however.

Mr. FORD. Have they been actually submitted in concrete form?

Dr. HAGEN. Yes; there have been submissions in concrete form.

Mr. FORD. Approval as of now?

Dr. HAGEN. As of the present there is no approval of any further program.

Mr. FORD. I gather it is possible that at the conclusion of Project Vanguard you might have some hardware that could be used for an extension of Vanguard plus the talents of the individuals who work on Vanguard.

Dr. HAGEN. If by hardware you mean rockets, no. At the conclusion of Vanguard, I trust we will have launched all of the rockets we purchased to do the job. What will be left after that is the organization and the facility and the big computing facility, for example, and then the laboratory facilities for instrumenting the rockets, the facility at Patrick for launching these rockets, things of that nature. But the actual rocket hardware I hope will be all shot away.

Mr. FORD. Looking back to the period when the decision was made that Vanguard rather than Orbiter would be the United States IGY satellite program, do you feel that a wise decision was made as far as Vanguard is concerned?

Dr. HAGEN. I believe, looking at the situation in the whole, a wise decision was made. We have achieved a satellite in the IGY that has been, as many wanted it in the beginning, divorced from military hardware, purely a scientific venture. This, I think, has been to the good.

The question as to timing is one of those hypothetical things. It is quite possible, had the choice been made in the other direction, a satellite might have been in the air earlier than it was.

Mr. FORD. Again I want to congratulate you and your organization, Dr. Hagen, not only for the success of the venture but the fact that the money you got you apparently wisely used and are not going to need any more to complete your operation.

The CHAIRMAN. Of course, the importance of an observation like that, Doctor, as you appreciate, coming from a very, very, very, very important member of the Committee on Appropriations, ought to be very valuable.

Mr. FORD. When people come up with that kind of record we are apt to give them more money next time.

The CHAIRMAN. Then I have made a truthful observation have I not, Doctor?

Dr. HAGEN. Yes, sir.

The CHAIRMAN. Then a very, very, very, and a few more "very's".

Mr. FELDMAN. Doctor, you used the words earlier in your testimony "conflict of interest," and I believe it was in connection with the Advisory Committee as it appears in the legislation before us at the moment.

Would you indicate in what way there might be a conflict of interest in connection with such an advisory committee?

Dr. HAGEN. Yes, what I was thinking about is this: When one is about to choose such a Board, I think he should look for competence in the individual rather than choose an individual because he represents a certain area in the community. When the individual serves on the Board as a part-time employee, really, it would seem to me that his basic loyalty would be to his full-time employer and that it would be very difficult for some individuals to separate their loyalties and to make unselfish and unbiased decisions on the Board. There could very well be a tendency in time to do, if I may use the word, a kind of logrolling where A will do something if it will satisfy B and in return get his favor. This kind of thing would be very unfortunate. That is one of the reasons I so strongly recommend that the members of the Board be chosen for their ability, be chosen over a wide area, and be full-time employees.

Mr. FELDMAN. We have laws on our statute books dealing with conflict-of-interest situations.

Dr. HAGEN. I realize you do. I do not really mean to create the impression that this action would be intentionally dishonest. I believe it is the kind of thing that skirts the law, yet is bound to come up when you are dealing with a group of people, that one must always consider how his actions affect the others.

Mr. FELDMAN. Doctor, we have had testimony before this committee from various witnesses stating that their experience with the AEC has been excellent.

Now, in the AEC—when I use the words "AEC" I mean the Atomic Energy Commission—in the act itself there is a provision for military liaison. As I just stated, that has functioned very well.

Would you recommend a corresponding provision in the legislation that we have before us at this time?

Dr. HAGEN. Yes, I would, and this goes back to a question asked earlier this morning. It would be unfortunate and perhaps unwise to have Department of Defense or military membership on the—suppose we did have a 5-man Board—on this 5-man Board because of the desk and not of the man. However, there is bound to be a great interplay between this Agency and the Department and for that reason I believe the same liaison mechanism that is used for AEC would be helpful.

Mr. FELDMAN. Doctor, it might be difficult to write a substantive provision that the Administrator or Director or Chairman of the Commission be on a level equal to that of the Security Council or a high level, but that could be included certainly in the declaration of policy in a bill. Would you favor such a declaration?

Dr. HAGEN. Yes, sir, I certainly would.

Mr. FELDMAN. I think we are agreed the scientific resources and talents of this country must be harnessed effectively. I think you said that this morning about the space program. What would your reaction be to developing or providing a central register of such technical talent? Could you develop for us the possibilities for some plan to corral our trained people?

Dr. HAGEN. I wish I knew how to do it. If I did I would tell you but I think it is a monumental task. It has been attempted. I believe there are on IBM cards a compilations of the talents of individuals in this country that was started, I am sure, during the Second World War. But it is a difficult thing to manage——

Mr. FELDMAN. It would have to relate to a specific field and so on. This is a monumental task but if it could be done would you consider it worthwhile?

Dr. HAGEN. If it could be done, I certainly think it would be worthwhile. It is a disgrace, to waste the manpower and the brains in this country when we so sorely need them.

Mr. FELDMAN. It might also prevent any stockpiling of scientists by particular companies, is that right?

Dr. HAGEN. That is right, and that is why I believe it would be so very difficult to implement such a thing. You would have to have not only the capabilities of the individual but you would need to know the inner workings of the company, to know how the man was being used. In our way of doing things, this is a very difficult thing to see.

Mr. FELDMAN. I believe it would be a difficult thing to do completely, but at least an attempt should be made in that direction. Is that your feeling?

Dr. HAGEN. I feel that an attempt should be made in that direction, yes.

Mr. FELDMAN. Dr. Hagen, were you consulted during the course of the drafting of the proposed bill?

Dr. HAGEN. Of this bill?

Mr. FELDMAN. Yes.

Dr. HAGEN. No, sir.

The CHAIRMAN. At that point, will you carefully look it over and, as I suggested before, make your recommendations or suggestions to the committee?

Dr. HAGEN. Yes, sir, I will.

(Material referred to is as follows:)

The proposed bill, in my opinion, is basically a good one, and the NACA is a competent scientific organization. Apart from the discussion made in my testimony I have these specific recommendations and suggestions:

Section 2, page 2, lines 4 to 10. This should be carefully worded so as to not exclude participation by components of the Defense Department which have general capabiilties which also contribute to weapons programs.

Section 2 and section 6 (a). The mission of the agency should explicitly include exploration. Measurements are presently being made and operations conducted in space using scientifically instrumented but unmanned vehicles. When the preliminary investigation and probing have been completed it may well be decided that it is in the national interest to send a manned space vehicle to a location away from the earth. This bill should authorize the space agency to conduct such manned exploration.

Section 3, line 10. The Director should also have authority to assign portions of the program to other agencies where capability exists.

Section 4. The best-qualified men should be on the Board. I see nothing wrong with the majority coming from Government if they are the best men.

Through a reference to section 4 (a) 2 the wording in 4 (b) becomes too restrictive. There are many people of high competence in Government service and the country should not be denied their services as a Chairman of the Board.

Section 5 c. The interpretation of the word "consult" should be clarified. For example, does consult as used here imply obtaining approval?

Section 6 (b) 2. Giving a new agency authority to operate outside the Classification Act of 1949, supposedly to help attract high-grade personnel on the basis of equal pay for equal work, is not a proper solution of the problem. This approach tends to degrade the civil service system. A recommended procedure, more fair to existing agencies and employees, would be to adjust all civil service salaries in this area of work on a basis of equal pay for equal work.

Mr. FELDMAN. Your project began in the fall of 1955 and your first satellite went into orbit on March 17, 1958. It took you over 2

years. Why was that, when it took the Army only a few months after the go-ahead to launch a satellite?

Dr. HAGEN. I think the best way to go at that is to go back to 1955, at the time the decision was made to use project Vanguard. At that time there was no hardware in this country capable of launching, or even acting as the first stage of a vehicle which could launch, a satellite that would satisfy the needs of the International Geophysical Year program. The decision was made then to go ahead with Vanguard. Now, we did proceed with Vanguard. We had a sense of urgency within the project, and we had certain priority restrictions upon us. We proceeded as rapidly as we could.

One of the competing projects was the Army project which was referred to a moment ago, the Orbiter project, based on the then Redstone vehicle. That, however, had a capability of launching into orbit, I believe, five pounds, which was not sufficient for the IGY purposes.

I have read recently that the Army continued the work on the Redstone launching vehicle, which then became the Jupiter-C, as a reentry vehicle and it so happened the geometry of this reentry test vehicle was just the geometry needed to make a satellite launching vehicle.

So that when the Army was requested in October or November—November I believe it was—to come into the program and aid with the backup, they had already developed the vehicle as a reentry test vehicle and what remained was to instrument a satellite to go into it.

Mr. FELDMAN. The Army insists it could have launched a satellite in 1956 but was denied the go-ahead.

Can you state any reasons why the so-called Stewart Committee gave you the job in 1955 instead of to the Army?

Dr. HAGEN. I partially answered that before. Because the Committee believed that the Vanguard vehicle proposed at that time had a greater chance of putting a larger satellite in orbit during the IGY than the Redstone vehicle.

Mr. FELDMAN. The Army and Air Force plan to use stages of the Vanguard in their shots to the moon? This must indicate that they think a good deal of the Vanguard.

Dr. HAGEN. Yes, sir. We take that as a compliment on the design of the Vanguard vehicle. I think the point that is of interest here and perhaps the answer to your question is that the Vanguard vehicle is designed as a very efficient rocket. We—I mean the people who worked in the group and who did this design—realized that the efficiency of the rocket must be a maximum in order to achieve its purpose. This means that they did everything to reduce the deadweight. So they came up with stages in that rocket, with the first, second, and third stage; each of them is a highly efficient rocket. The third stage is one of the most efficient rockets that we have in this country today. In the same way, the second stage is a very efficient rocket for the purpose for which it was designed. These two stages are the two that are being placed on top of the other vehicles to do this moon shot.

Mr. FELDMAN. One last question, which is a technical one.

I have heard that a satellite at a certain distance from the earth, 22,000 miles or so, would stay over the same spot on the earth all the time because the satellite travels in its orbit just fast enough

to match the spin of the earth on its axis. Why not place one over a given city or other interesting place to keep an eye on that spot?

Dr. HAGEN. I am going to have to talk with my hands to answer that one.

If we were to launch a satellite in an orbit around the Equator, then this statement could be exactly true. If it were put up over Quito, Ecuador, for example, then as the satellite goes around in its orbit the earth turns on its axis and they both go at the same rate. The period in the orbit is determined by how far out we go. So if the satellite were started out over Quito, it would stay over Quito, going at the same rate the earth turns.

If we tried to do the same thing for Washington, we would be in some difficulty. If we inclined the plane of the orbit of the satellite to the Equator at 38 and a fraction degrees, then at the top of its swing the satellite would be over Washington. But one thing is important in this satellite discussion, and that is that the plane of the satellite's orbit has to contain the center of the earth. So if the satellite starts out over Washington, it does not run around the parallel of latitude, 38°, it goes down across the Equator and then back up again.

Now, if we make this satellite have a 1-day period, then it goes around its orbit at the same rate the earth is turning; it starts at Washington, but as the earth turns it goes south and then comes back up again, so that it would swing all the way from Washington down to Santiago, Chile, and back again.

Therefore, if you did that kind of thing and your latitude is north or south of the Equator, instead of staying overhead the satellite would appear to move in a north-south line once a day.

Mr. FULTON. You were talking, of course, about an unpowered satellite and one that is not possibly put up with a twist.

Dr. HAGEN. Yes, all of the satellites that I have talked about, I think, have been unpowered. That is, once they are put into an orbit, there is no further power. They just coast along.

Mr. FULTON. If there were an alternating rocket thrust built into the satellite, you could at times correct it because it is merely a 38° variation over a 12,500-mile arc.

Dr. HAGEN. You would have to use a lot of energy to continue to do this. In modifying the motion in that way you would have to assert a thrust and control the direction of the thrust continuously.

Mr. FULTON. By accelerating at a certain period, would that help you out, because when it starts away from the Equator or comes back toward it—that is, the satellite in its orbit—in regard to the rotation of the surface of the earth it is either going faster or slower.

Dr. HAGEN. Unfortunately, once you stop accelerating it then it will go along in a classical orbit. The orbit must always contain the center of the earth, so that if it is north of the Equator when you stop your acceleration, then it is going to pass south of the Equator in order to make the plane contain the center of the earth.

Mr. FELDMAN. Would you care to comment on what you think the Russians are doing now in a specific way on the space race?

Dr. HAGEN. I do not think I can say much in addition to what I have already said about them.

I believe they are moving forward and you can anticipate new surprises.

The CHAIRMAN. Any further questions?

Thank you very much, Dr. Hagen. You have been very patient and very helpful. For myself as chairman of the committee and the other members of the committee, I express to you our sincere thanks.

Dr. HAGEN. Thank you, Mr. Chairman.

The CHAIRMAN. The next witness is Dr. Fred L. Whipple, director of the Smithsonian Astrophysical Observatory at Cambridge, Mass.

We are very glad to have you with us, Doctor. We hope to benefit very much from an expression of your views as we have all other witnesses who have appeared before us.

Have you a prepared statement?

STATEMENT OF DR. FRED L. WHIPPLE,[10] DIRECTOR, SMITHSONIAN ASTROPHYSICAL OBSERVATORY, CAMBRIDGE, MASS.

Dr. WHIPPLE. I have no prepared statement but I should like to make a few remarks in lieu of that.

The CHAIRMAN. Go right ahead, Doctor.

Dr. WHIPPLE. I deem it an honor and indeed a great privilege to have an opportunity to discuss this bill before your committee.

In making a general comment on the bill, I must say that I am of the considered opinion—I read it very carefully indeed—that this was devised with extraordinary wisdom and foresight and I feel that the bill is an extremely important one to further science and for the future security of our country.

My connection with this program is through the satellite tracking program of the Smithsonian Astrophysical Observatory.

We have been assigned the task of tracking the artificial earth satellites of the International Geophysical Year program, by optical means. We started on this with very limited funds to begin with, 2 years ago in January, and we were planning a culmination of the program in the middle or early part of this year.

The program consists of two major portions. The first is the Moonwatch program instituted to utilize volunteer observers throughout the world who could make satellite observations with small telescopes. That program has worked out, I think, quite successfully.

I think it may be of interest to this committee to know that the Russians set up a volunteer, at least a similar program, following the same principles that we have used, for some 70 stations in the U. S. S. R. We have about 126 stations of volunteer observers in the

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United States and somewhat over 100 in other countries as a part of the International Geophical Year program.

The major portion of our program, however, was to set up 12 observing stations with large photographic cameras for precision observations of artificial earth satellites throughout the International Geophysical Year. Those stations are mostly set up and are being completed at a rapid pace today.

The program has required the cooperation of a number of countries all over the world and we have found extremely good assistance in so conducting the program.

I may say for the program to be successful in the sense of sufficient observations of many satellites, or of some satellites over enough revolutions, it will be necessary for this program to continue on beyond the International Geophysical Year. At the moment we do not know a source of funds for the continuance of that program. However, it was set up to operate to June 30, 1959, instead of December 31, 1958. So we have a bit more time to search for funds in the future.

But I think this will illustrate a general problem of the high-altitude and space programs in this country; funding not only does not exist beyond the end of the International Geophysical Year or thereabouts, but there is no clear indication of any sources of funds for the continuing of the space programs after that time.

Now, I feel that the scientific exploration of space is of vital importance to our country. It has been stated here that we are following the leader. I do not agree that that is a proper connotation. The leader happens to be going faster than we are. We might use the analogy of a racetrack or a cinder track, where the course is clearly defined. The leader is ahead of us and only in that sense are we following the leader in this program.

If he were outside the cinder track, off in the bushes somewhere, then we certainly would not follow him and we could relax a great deal in contemplating this program. But he is indeed carrying on an extremely effective program, begun immediately after World War II, and so far as I can ascertain from the information I have available, has been pursuing it with a clear-cut intention of exploring space and of mastering space.

So I feel that it behooves us to act wisely, effectively, and strongly in this matter. That means that we must coordinate our efforts and utilize our manpower to the best possible advantage.

For that reason I feel that we must have an organization of the type you have visualized here with a very high status in the Government so that it can operate at a comparable level with the Defense Department and other agencies that are interested in this problem. I think this national space agency should be the coordinating agency for the activities in space research. That does not mean that it should control this activity, but it should be in a position of coordinating. I do not see any agency that is in that position at the present time.

The organization should be at a high level and it should be, I think, independent of the military, not because the military are not competent; they are indeed competent; they are also very conscious of the significance of science in the defense of our country. I have made the statement privately a number of times and I would like to make it publicly here: that since the end of World War II, in my opinion, outside of the academic world there is no group in the United States that is more conscious and appreciative of the significance of science

in the future security of our country than is the military. They have gone to great efforts to promote basic science. I think in many cases they have "bootlegged" basic science into their programs because they realized it was necessary and because, until very recently, we had no national organization to fund the basic research that would be of value to them.

But in this particular case. I feel that the space exploration should not be under the control of the military because their objectives are not the same as the objectives of this space agency should be. The interest of the military must center on specific defense equipment. They must, by the nature of their operation, concentrate on shorter range goals than basic research.

I do not think we should consider the problem from the viewpoint that the scientists should be under the control of the Government in exploring space. There are two aspects to this problem, in my opinion: (1) The United States Government should give its scientists the opportunity to make the basic explorations that are so important to our future. (2) The United States Government should then, of course, adopt policies as to the utilization of space and what is to be done with the scientific results and the instrumentation that result from the program. This point of view is slightly different from the one mentioned this morning.

It is my opinion that there is no better expenditure of the taxpayers' money, for the future of this country, than in basic research. It pays off in the long run with greater dividends than any other expenditure of funds that we make in terms of the future of our country, the future of our ideals and of our democracy.

That is why I feel so strongly that this national space agency is a vital and important agency for our country.

There would be a great many very tangible and explicit benefits. I do not want to take much time in discussing these but I should like to point out, for example, that weather forecasting, in my opinion, will become a science instead of an art. When it is possible to make observations continuously over the entire earth's surface of cloud coverage, the temperature, the water vapor content above the reflecting surface and the wind, and on a daily basis, the satellites will then provide the information necessary to give us a sound theory of weather. This theory, coupled with the great computing machines to utilize the data and to apply the theory in terms of the observations, will make weather forecasting an exact science. I predict that knowledge of weather alone, in its value to the country, will greatly outweigh the cost of the entire program.

I think there will be many, many great advantages that will come, as we might say, on the side.

One example is the use of a substitute for a man in a satellite. If the scientist conducts his program he is going to put as few men as possible up there because sending them is extremely expensive. Scientists, I think, are a most economical, carefully minded people in this respect, at least as careful as anybody in this country as a group.

It is uneconomical for scientific purposes to put man up there to operate instruments. It is going to take time, however, to develop substitutes.

The first move will be to put men there. But at the present time, the telemetering systems that have been developed in rocketry can send back and read more than a hundred instruments several times a second

with an accuracy of 1 percent and send the data back to the earth. It is clear that the crew necessary to make that many observations in space would require a ridiculous amount of equipment.

Mr. McDonough. Will you delineate the variety of information you can get by telemeter?

Dr. Whipple. This information is limited always to the reading of scientific equipment. It can be a voltmeter, a cosmic-ray counter, a meteor counter, an ultraviolet-radiation measuring device from the sun, and it could be a television receiver to transmit a picture back.

On the other hand, the problem of servicing equipment in space is extremely difficult. I visualize, in the long run, the use of a device, which, for want of a better name, I call a telepuppet, a remote-control device, a type of robot. By television eyes it would enable us to see within its space vehicle. It would have some motion within the vehicle and would have ability to follow the motions of the operator's hands, the operator being on the ground. The telepuppet in space would then duplicate the actions of the operator's hands on the ground and therefore make servicing possible.

Now, this type of equipment is already in existence on a minor scale in the "hot" laboratories, and is a device that should be pursued. This is an example of the type of valuable side development possible.

I point out that when such devices are well developed they will have multitudinous practical purposes on the earth so that mankind will not be endangered in doing dangerous work. I can see the time when telepuppets will do our unusually dangerous mining underground so that we will not have to worry about mine cave-ins, explosions, etc., and also deep sea operations.

This type of benefit will come on the side, as it were, without even being considered part of the program, and this is only one of them.

Now, I want to mention again another reason why I think space exploration should be under civilian scientific control. Let us take the long-range point of view. The scientist wants to understand space, the phenomena that occur there; he will, therefore, conduct studies that may not have immediately obvious useful purpose. But we have found from experience, and I need not belabor this point, that researchers into the unknown inevitably pay off in practical benefits. Here I think there is no question but what the benefits will be enormous in comparison to the cost.

Now, I must point out again that I hope that the operations here will remain in an unclassified level in terms of security classification, insofar as is possible. This is very important. I do not want to go into details here but I have encountered before this question of classification, particularly a number of years ago in the upper atmosphere rocket research program with the RDB. At that time there was pressure to classify that research work. The main argument, I understood at that time, was that the measurements of the high atmosphere were expensive and therefore should be classified.

This argument I thought was not a correct one, and it has been interesting to note what has happened.

The results were not classified, for which I was very pleased, and in discussing problems of such fundamental data as the density of the high atmosphere within the rocket range, the Russian scientists with whom we have talked during the past year have seen our published data and only recently have presented their own material.

I saw the results of theirs last fall for the first time at the meeting of the International Geophysical Year here in Washington.

The interesting point is that the Russians were not taking our results about the upper atmosphere and utilizing them directly as fact. They were highly critical of our results, and, in fact, said they were not so good. They considered theirs better than ours in spite of the fact that we have had an extremely good upper atmosphere research rocket program carried on by extremely competent people.

My point is that this sort of information is of great value to our other scientists and it is very doubtful, in terms of basic research, that we are going to be much ahead of the U. S. S. R. in any zone. We may be ahead here; they ahead there. The net result is the improvement of science, which is good for the world internationally as well as good for us.

Mr. McDONOUGH. Did they have any comparative data that was better at the time they criticized ours?

Dr. WHIPPLE. I think they did. They were criticizing us particularly with regard to density and temperature above an altitude of 100 kilometers. I would not want to make an absolute statement, but it is my impression that their data were better than ours.

Mr. McDONOUGH. Is that not a normal attitude for them to criticize what somebody else does, to indicate that theirs is superior?

Dr. WHIPPLE. I think every scientist tends to criticize somebody else's work until he is sure of the right answer.

Just one last point about the security angle: Security officers take the point of view that any information that might be useful to the enemy or potential enemy should be classified. This, of course, is not the point in question at all. Every time any item is classified there is a certain loss to us. The question is whether the benefits they will gain outweigh the price that me must pay in loss of efficiency or otherwise; if that benefit then is greater than our loss we will gain by classifying; and the material should be classified. But the problem is very difficult. The tendency is to overclassify and therefore hamstring our own operations.

Mr. FULTON. Would you yield a minute?

Did it not shock you a little when you heard the Russians were not playing open with us on the IGY and suddenly we found that they had information that our very open-minded scientists had not known about, when we had given full exchange?

Dr. WHIPPLE. They said they were going to put up satellites. When we asked them as to masses, were they planning payload satellites smaller than Vanguard, for example, their statement was that they were considering some as small but others much larger.

I would say that the only case so far in which have not played square with us is with regard to the frequencies that they used in their radio transmitters. On the other points they did not state the times of launchings but they told us they would not state the times of launchings until they had made successful launchings.

Mr. FULTON. Have they given any United States scientists the results of their Sputniks I or II or told you the codes they were operating around the earth?

Dr. WHIPPLE. Our opinion and theirs agree in that the observation material should be primarily under the cognizance of the country sending up a satellite. I should expect that they will transfer to us

measurements they have made of the transmissions from our satellites. I think this will be a good test as to whether they transfer to us their tapes and records of our radio transmitters.

They have very little other information that they could transmit to us.

This summer will tell the story as to whether they do indeed give us the scientific information that they have obtained. Reduction and interpretation are laborious and time-consuming while telemetering codes are of little use to others.

I may say on one point they have transmitted a very useful piece of information, that the first sputnik satellite, the sphere, was not punctured by meteors in space.

Now, I feel that, in terms of this whole effort, the National Space Agency can indeed make more efficient, and in fact most efficient, utilization of the manpower in this country. I feel that it is extremely important that we do not allow any of our resources such as our scientific groups, organizations and facilities who are able in space science, to wither away.

To my knowledge, for example, there is no coordinated program continuing the upper atmosphere rocket research beyond the International Geophysical Year. I do believe that some of our military services are carrying on their own programs but I do not know of any coordinated program to continue this research, which is absolutely vital.

We are making a good start on a very much less expensive rocket study of the high atmosphere. I feel that such an agency as proposed here is extremely important in coordinating the efforts of all of these groups in the country.

This means, of course, that the Astronautics Agency must have knowledge about who or what groups are able to do this and what groups are able to do that; therefore the operation must be very specifically coordinated with the military programs. It means, of course, that the Agency must be well funded so that it can let contracts to the universities, to commercial organizations, and, possibly, to the military organizations. It must have close liaison with the military so that when a special problem comes up, particularly a large effort, a decision can be reached as to whether that project will be conducted within one of the services or by the Astronautics Agency.

It is extremely important that this coordination be made so that we can utilize the force, the manpower that we have. And it is particularly valuable to keep these technical and scientific teams going in an effective manner so that they have confidence. That means that the Agency needs to have power to commit, in one fashion or another, activities for more than a year. These are often long-term projects and it is absolutely vital that the team conducting the project know that it is going to be financed long enough to complete the job.

That does not mean that we have to take action on a crash basis. I think there are a few things that need to be done, a few decisions to be made on a crash basis, to assure that we continue the programs we have started and keep the teams in this area operating properly.

But for the long-term program, I should think it is vital that this National Agency be set up on a very sound foundation, that it be planned so that it will continue on with long-range goals not limited by 1, 2, or 5 years, and so that it can then plan and organize a con-

sistent long-range program for the exploration of space and the science that goes with it.

The CHAIRMAN. And to expand, I assume you have in mind?

Dr. WHIPPLE. I would assume to expand to a certain extent. I have no idea how great this expansion should be. That is very difficult to see at this time. It depends, for example, on miniaturization.

It has already been demonstrated that we can put an enormous amount of equipment in a few pounds in space, I do not see how one does that with a telescope, which I think is very important, but even so the weights can be reduced. So it is difficult to say how expensive it is going to be.

Clearly in problems of physical exploration, sending men about the moon and to the moon's surface, one is going to have to go into more expensive programs.

But I do think that, if this is a civilian-controlled agency, it will be done in the most economical way possible and that the scientists generally like to do things neatly and generally like to cut administration as far as possible.

The CHAIRMAN. I meant expand, speaking of the related activities within the agency created.

Dr. WHIPPLE. Yes; I would visualize considerable expansion in that direction.

The CHAIRMAN. That is how I use the word "expand."

Dr. WHIPPLE. I am certain in my own mind that the proposal here is going to demand a complete change of viewpoint on the part of the NACA, National Advisory Committee for Aeronautics.

The CHAIRMAN. It is a complete reversal.

Dr. WHIPPLE. Yes. The policies here are quite different from the practices and policies of NACA, as I understand them, and involve, it seems to me, a great deal of contracting to commercial agencies, universities, nonprofit organization, and possibly the military.

As I understand it, the NACA has had the policy of doing most of their work "in-house." This will require a change in policy of a marked sort in their operations as well as in the detailed areas of research and development.

The CHAIRMAN. Now, largely in the past, it has been giving advice like, for example, aerodynamic designs of airplanes for civilian and military purposes.

If a bill along this line is enacted into law it puts the Agency in an entirely different position so far as primary objectives are concerned.

Do you think they are wedded so much to a path that they are capable of having the vision, the foresight, and the dynamic spirit to adjust themselves or whether we should create an entirely new agency?

Dr. WHIPPLE. I cannot answer that in a "Yes" or "No" fashion. I must say that they have done very fine work in the past and I think that a very heavy reshuffling would be necessary probably but it seems possible to me that they could indeed turn over a new leaf and attack this new problem effectively because there are some extremely competent people there.

The CHAIRMAN. Go ahead, Dr. Whipple.

Dr. WHIPPLE. I want to go on with a few comments about the bill. With regard to the 17-man board, I feel that this organization should have a very strong Director and that he should be given enough power so that he can act promptly and effectively.

It would seem to me that the 17-man board has in this bill enough power that if it felt necessary to provide the Director with more immediate assistant or he felt the need of having more opinion, they could have an executive group full time and they could appoint a great many panels and advisory groups to help out.

My own impression is that the 17-man Board is rather important because you can get from it representation in quite a number of areas in the Government, in the educational field, and in industry, so as to obtain a broader point of view in forming fundamental policy.

It would seem to me that the bill is broad enough to enable them to operate respectively by working out their own details themselves.

The CHAIRMAN. You are in some disagreement with Dr. Hagen.

Dr. WHIPPLE. I think a bit. I think this problem he brings up is important. They could have a small working group in the council or in the executive committee that was full time and carry out the functions that he had in mind.

But this is a matter of detail. The important point to me is that the Director be a man of extremely great ability and that he be given enough power to carry out this project effectively.

The CHAIRMAN. What do you think of a commission form of agency?

Dr. WHIPPLE. I do not have strong feelings on this one way or the other. It seems to me that the proposed system has a little more flexibility in it because the 17-man council could then set up its own organization to take care of whatever problems come up for decision.

The CHAIRMAN. Supposing one man is wrong?

Dr. WHIPPLE. You mean the Director?

The CHAIRMAN. Yes.

Dr. WHIPPLE. Then they should be able to fire him.

The CHAIRMAN. Don't you think a limited collective viewpoint is much better than an individual viewpoint? I am not talking about large numbers now. I am talking about a commission of five.

Dr. WHIPPLE. I would not be able to answer that with complete confidence. I feel that they could, within the powers given them here, set up a smaller group if they wanted to carry out this function and still have the broad representation of policy that a 17-man board would give, and which would not be given by a 3- or 5-man commission.

That is my point of view on that. Now, I feel it is very important that the salary level be adequate so that the scientists in the Astronautics Agency can be gotten on a competitive basis with industry and with other possibilities for them.

The CHAIRMAN. There is no difficulty, so far as I am concerned, with the provision of the bill, but when you allow this new Agency to appoint without regard to the Classification Act, then you have to consider other scientists employed elsewhere in the other activities who are bound by the Classification Act.

You can see the relative situation there. Then, when we come to that, this committee probably would not have jurisdiction over the

broad question. We would be clashing with the jurisdiction of the Committee on Post Office and Civil Service. That calls for no comment on your part; that is our headache. But I call it to your attention to show that, while I, personally, agree with the provisions of this, again, what about Dr. von Braun and his scientists, the scientists associated with him, Dr. Hagen, where they are subject to the Classification Act?

Are you under the Classification Act?

Dr. WHIPPLE. The policy is that we shall follow the Classification Act, which we do, so we are handicapped in the same way.

The CHAIRMAN. How would you feel if they found in this new Agency they could pay their scientists higher salaries than you can pay yours?

Dr. WHIPPLE. I would advise my scientists to get a job in this new Agency.

The CHAIRMAN. In other words, it would not be a very happy situation for you.

Dr. WHIPPLE. No, but I think, if this were done, it would be a first step which would lead to a correction, which I think is an error in policy.

The CHAIRMAN. There is something to that. In other words, you feel if it were put in this bill it would be the impetus for the others to be extended?

Dr. WHIPPLE. Yes.

The CHAIRMAN. Well, there is a thought in that.

Dr. WHIPPLE. If it is not done, I fear there will be a continuance of the present tendency, of loss of some scientists to the Government, both in the military and in the departments.

Mr. McDONOUGH. Mr. Chairman, I have a question there. For the number of scientists that we have in government now, astronautics astrophysical, and in space exploration, how do they compare with the same group outside of government in private industry right now?

Dr. WHIPPLE. Must I answer that question? I would like to be excused on the grounds——

Mr. McDONOUGH. Let me help your answer then. Do we have as many competent men in government service in these categories of the higher sciences as there are at the present time in private industry?

Dr. WHIPPLE. Would you excuse me if I answer that in a slightly different way, that if there were not this differential in salary you would have more scientists and more competent scientists in the Government than you have today.

Mr. McDONOUGH. Then they are available at the present time?

Dr. WHIPPLE. Yes.

Mr. McDONOUGH. They are available?

Dr. WHIPPLE. They are, a limited number, but this would also draw out more young men into science than are going into science today, because the salary considerations are a major factor in career decisions among young men. This is very vital for the future.

I had not intended to expand on this point, but it is quite clear that the Russian educational system is training more scientists, more engineers, more technical people than we are training, by a factor of 2, and is doing that by making the incentives high.

This is one way in which we can start this ball rolling here. I think that is one of the most vital points in our long-range national security, the drawing of able youngsters into science.

The CHAIRMAN. Have you finished your statement, Doctor?

Dr. WHIPPLE. I think that is adequate.

The CHAIRMAN. Mr. O'Brien?

Mr. O'BRIEN. In the interest of time, I have no questions.

The CHAIRMAN. Mr. Metcalf?

Mr. METCALF. I reserve my time.

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. No questions, Mr. Chairman.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. I am going to ask the doctor one question. Will you elaborate on the discussion you heard this morning with reference to the menace of the satellites in space or an unusual number of satellites?

Dr. WHIPPLE. May I take 1 minute to answer that? I believe this morning that Dr. Hagen was referring more to the confusion in the radio broadcasting of many satellites on the same frequency, and I consider the chance for collision negligible.

I think the tracking problem, if anything, will be made better by having more objects to observe, because there is nothing like the boredom of operating these tracking systems with nothing to track. If there are more objects there, I think you will find your crews more alert.

The danger of satellites falling on people and property is so small, at least compared with the natural hazards of meteorites, that the problem will never become a serious one. That is my answer, but I will be glad to elaborate.

For geodetic research, to measure the shape and size of the earth and the precise separation of the continents and their geodetic networks, long-lived satellites are necessary. Otherwise, the rapid orbit changes from high atmospheric drag reduce the accuracy of the results. Orbits with their planes at various inclinations to the earth's Equator are also desirable for this research. Hence, I hope that a good number of long-lived satellites will be launched. From the tracking point of view, a large number (100?) satellites could be followed at one time without confusion, although the cost of the operation would be appreciable.

To destroy a satellite, other than by its own internal explosive, would probably be more explosive than launching it. I do not view with alarm a large increase in the number of artificial earth satellites.

The CHAIRMAN. Doctor, will you put into the record some of the problems of the classification of information that you referred to?

Dr. WHIPPLE. Yes, I shall do that.

(Material referred to follows:)

ATTACHMENT A

ON THE SECURITY CLASSIFICATION OF UPPER ATMOSPHERIC TECHNIQUES AND DATA

(By Fred L. Whipple, Harvard College Observatory)

(Prepared for the Research and Development Board in December 1952)

This discussion is divided into three sections: the first involves the losses to scientific research by security classification; the second the transition steps from basic scientific research to military instruments, and the third, the specific problem of classification of upper atmosphere techniques and data

A. *The loss to scientific progress resulting from security classification*

Science can progress rapidly only through the exchange of ideas, techniques, and data. The detailed manner in which security classification impedes free exchange and imperils the progress of basic science deserves some analysis. Let us first note the character of security classification as stated by regulations of one of the military services:

"No person is entitled solely by virtue of his grade or position to knowledge or possession of classified material. Such material will be entrusted only to those individuals whose official military or other governmental duties require such knowledge or possession. This principle applies equally to command control over the dissemination or distribution of classified matter as well as to individual discussions."

These regulations are obviously well-suited for the proper operation of a military organization whose plans or knowledge must be kept from the hands of the enemy. Such restrictions on the transfer of scientific knowledge, techniques, or data, however, are stifling to scientific research as follows: (1) It is eminently impossible for the person in charge of classified information to know specifically what scientific knowledge may be of value to each individual scientist; (2) it is not generally advisable to give each scientist free access to all classified material; (3) to give scientific information a different type of security classification than operational or strategic military information would probably be also impractical.

Hence, the scientist, if he is to learn the activities in other fields of science within classified areas, must, by unspecified means, learn of the existence of such activity, justify in detail his need to know about it, obtain clearance to learn about it, and finally, in many cases, make a journey to attain his goal. Only in the most vital circumstances can he expend all this effort to become better informed.

The losses to the scientist's individual progress and to the general progress of science occur, then, in at least the following ways:

1. By not being aware of the efforts by others, the scientist fails to contact able men who might give him specific assistance in his own problems.
2. The scientist may waste time solving problems that have already been solved, or proved unsoluble. Such unnecessarily wasted effort is devastating to the creative urge.
3. The scientists may lose the inspiration normally attained through broad contact with other scientists in widely diversified fields.
4. The scientist fails to gain new ideas by reading the general scientific literature, particularly in fields somewhat away from his own endeavor. Hence, the cross-fertilization obtained by applying techniques in one area of research into another area is greatly hampered.
5. The scientist tends to concentrate on a narrower field of endeavor and loses breadth of view.
6. Lack of broad contacts makes it much more difficult for the scientist to obtain a quick check on the validity of a new idea or technique. Since only a small percent of new ideas turn out to be of value, he will tend to get into the habit of discarding those new ideas that cannot be checked within his narrow range of information, or worse, of not seeking new ideas.
7. The lack of criticism by others in his subject, and the lack of immediate or possibly even ultimate criticism of his efforts, not only hampers the scientist in obtaining the correct or inspired scientific results, but also leads him to an attitude of less self-criticism and less scientific rigor. There can be no doubt that sometimes the cover of security classification is used to hide inferior scientific contributions.
8. The training of new scientists as graduate students is seriously impaired by security classification.
9. The handling of classified material and the maintenance of security wastes the scientist's time, consumes his energy, and creates nervous tension. This is particularly true for the scientist whose institution does not accept classified contracts or who must, for other reasons, work in relative isolation.
10. The nuisance of security checks on open publication and the complications of classified publications reduce the outflow of a scientist's published contributions.
11. Classified scientific material does not exist for the many scientists who do not work on Government contracts.

Thus, the effects of security classification are to dull scientific initiative and inspiration, narrow the field of an individual's research, reduce both the quantity and quality of his work, and impede and stifle progress in new or borderline fields of research. For these reasons, many of the most able scientists will not enter the field of classified research except in the case of national emergency.

The unhappy effects of security classification can, to a certain measure and in certain situations, be alleviated by the establishment of large research organizations in which the basic scientific research activities are not compartmentalized. Thus, a relatively free scientific exchange can be established among a rather large number of workers. Scientists in the smaller, and particularly borderline fields still suffer severe handicaps even under these most idealized conditions of research under security classification.

There appears to be no way in which security classification increases the quantity, quality, or breadth of basic research and a large number of ways in which it retards, inhibits, or halts scientific research.

B. Security classification in basic research and the transition to the development of military instruments

Since it is obvious that a few basic researches may, by their own nature, be of immediate value to the enemy, a practical balance must be maintained between the losses to research by security classification, and the gains obtained by preventing the enemy from access to the results or from a knowledge of the goal of the research.

In reaching the optimum compromises, the following points are of prime importance:

1. Security classification of scientific information imposes handicaps on ourselves as well as upon the potential enemy.

2. Security classification is justified only when the loss imposed upon the enemy appears to be greater than the loss imposed upon ourselves.

3 Classification of basic research will normally only delay the enemy, not prevent him from eventually discovering the basic facts. Thus, our scientific strength lies in progress rather than in preservation of our present knowledge.

4. Basic scientific knowledge is rarely, if ever, a defense weapon in itself. The road from the initial concept to a finished weapon is long and often uncharted.

Since scientific data and theory are the very building stones of technological progress, security restrictions at the basic research level will have the greatest effect in hampering our own progress. Such restrictions will not have a corresponding effect on the enemy, because he will certainly have knowledge of the same general kind, though perhaps not as complete or as accurate.

As the concept of a military instrument develops more and more toward its practical form, the technological development becomes more and more specialized, and the losses to the progress by security classification become less and less important. At the same time, the details of the design and probable performance become more and more valuable to a potential enemy. Probably, in most cases, security classification can best be imposed at the time when the concept is clearly enunciated as a potential tool of war and when a definite decision has been reached to attempt to develop the concept into a military tool. Classification of the research prior to the specific concept may indeed protect a single development more fully than classification at a somewhat later stage, but will delay or prevent the discovery of new concepts which may be even more valuable.

C. The specific problem of classification for upper atmospheric techniques and data

The chief arguments given for the classification of geophysical data are:

1. An enemy might use the data directly in the design or operation of some military instrument.

2. The data may reveal the performance of the vehicle used in obtaining it.

3. The data cost money, and therefore should not be given away.

4 The instrumentation for the research may be useful to the enemy.

In answer to the first argument, we note that an enemy who develops an instrument or system for high-altitude operation must have some data on the upper atmosphere to begin with and can readily obtain data of a specific nature from the instrument itself. Providing him with basic data concerning the upper atmosphere will add little to his already available knowledge and will be of no assistance whatsoever in the much more difficult problems of design and control.

Performance data of high-altitude vehicles, except for altitudes obtained, are rarely, if ever, necessary parts of reports concerning upper atmospheric research. In the upper atmospheric research so far conducted, the performances of the vehicles are so little above those of the German V-2 rocket of World II that the performance levels provide no additional information to a potential enemy. If there should be an opportunity for using a vehicle of much greater performance for basic high-atmospheric research but one that would require the classification of the results, then this panel is of the opinion that scientific progress would be more impeded by the classification than it would be by the lack of availability of the vehicle. Furthermore, it may be remarked that the scientists who are actually involved in the rocket soundings are fully responsible for maintaining the security of the vehicle's construction and operation under present regulations.

The fact that basic research in the upper atmosphere is expensive has no bearing upon the question of security classification. The chief result of imposing security restrictions would be to give us less return on an expensive investment.

The techniques used in upper-atmospheric research are adaptations of well-known principles in physics, and, in most cases, have no value except for the purpose for which they were designed. The communication devices and position-measuring devices used in upper-atmospheric research are largely classified and may well remain so. Their details are of no more significance in the description of the scientific results than is the design of the rocket motors used to propel the high-altitude vehicles.

The study of the upper atmosphere still remains essentially a virgin field of research. We now know the basic physical properties of the upper atmosphere, such as temperature, pressure, density, and composition, to a considerable height above New Mexico. We have very little information upon the general circulation and turbulence in the upper atmosphere. We have only preliminary indications of the dependence of these upper-atmospheric properties upon geographical position, season, or solar activity. Not even the vaguest suggestion of a comprehensive theory embracing the physical properties of the upper atmosphere in their relationships with the many phenomena of the upper atmosphere has been suggested. Type of phenomena to be interrelated, theoretically, include ionospheric phenomena, radio fadeouts, terrestrial magnetic activity, meteor phenomena, night-sky radiations, the anomalous propagation of sound, absorption of solar radiation in the upper atmosphere, disassociation, ionization, recombination, ion attachment, noctilucent clouds, and others.

In the basic research involving the theoretical integration of these many upper-atmospheric phenomena, we have received in the past enormous assistance from European scientists and scientists from other parts of the world. The problems to be solved are many, varied in character, and of extreme potential value in future high-altitude warfare. The imposition of security classification upon data obtained in our upper-atmospheric research would exclude most of our foreign colleagues who are extremely valuable to us in this research, would drive out of this field of endeavor a great many American scientists, and would greatly reduce the progress in this new field of research. Several important research organizations do not accept classified Government contracts, so that classification would automatically eliminate an appreciable fraction of the present research activity on the upper atmosphere.

The Geophysical Panel on the Atmosphere is of the opinion that the imposition of security classification on upper-atmospheric results and techniques would introduce far greater losses to our national-defense program than the minimal loss that might be so imposed upon a potential enemy. It is believed that research scientists, themselves, can be trusted to recognized and safeguard, by proper classification, such discoveries as would be of clear and immediate value to the potential enemies of the United States, if publicly revealed.

The fact that most upper-atmospheric research is supported by agencies of the Government cannot be regarded as a sufficient basis for automatic security classification of the results. The act of Congress establishing the National Science Foundation can be sighted as an explicit expression of public policy to the contrary.

The CHAIRMAN. And your views on the background of NACA and the need for high-level status?

(Material referred to follows:)

With regard to the NACA, there seem to be three areas in which rather drastic changes will be required in their operation. One I have already discussed, a required change in policy to increase markedly the percentage of contractual research and development that is necessary if our overall facilities and personnel in space research are to be used effectively. A second point concerns the nature of their research and developmental work. So far, following their assigned task, they have concentrated almost entirely upon problems of aeronautics. They have, indeed, shown some foresight in work on space sciences, but the percentage of their effort in this direction, I believe, is relatively small. I would expect, if the National Astronautics Act is consummated, that their in-house work on space sciences would be comparable to or greater than their present aeronautical work and that their total operation would be increased in scope by a factor of several times. This change in emphasis is not only an organizational and policy problem, but a real problem of finding the proper manpower for their in-house work and their administration of contractural work.

In the third problem area, I am not so well informed, but believe that the question revolves around the nature of NACA's present task, particularly its relationship to the air arms of the Defense Department and to the aviation industry. I gather that much of their high-priority work concerns troubleshooting of new equipment for the air services and, also, a considerable amount of development of new, required equipment If my hopes for the National Astronautics Agency are well founded, the duties would revolve much more on the basic scientific problems in space, that is, basic research, with a weaker role in development than they presently have in the field of aeronautics. This change of emphasis with regard to their point of view may, perhaps, be the most difficult of the problems for them to solve

Do you think that the IGY should be extended?

Dr. WHIPPLE. I feel that this National Astronautics Agency can indeed cover many of the functions of the IGY, and also, I feel that the National Science Foundation in its now, I hope, expanded program, can also cover some of the needs.

I feel that the IGY had the great benefit of arousing international interest to a high pitch for a short period of time, which is extremely valuable with regard to the programs that involve quantities that need to be observed on a worldwide basis. It would be impossible to sustain that high pitch over a long period of time.

Therefore, it seems to me that some of the research we are doing in the IGY should be continued by funds from the National Science Foundation and in the space studies by our National Astronautics Agency.

The CHAIRMAN. Mr. McDonough?

Mr. McDONOUGH. I do not want to take up too much time; I realize it is late.

In reference to this possibility of collision of satellites it is within the orbits as we now have them in space that you are speaking about; is it not?

Dr. WHIPPLE. Yes.

Mr. McDONOUGH. If we shot a satellite to a point beyond the present orbits, would it continue to orbit the earth if it went out 10,000 miles?

Dr. WHIPPLE. Yes; in fact, out to 250,000 miles, until it might encounter the moon and be destroyed in that fashion or be knocked out of the system.

Mr. McDONOUGH. What is the possibility of comets in irregular orbits that we know about colliding with a satellite?

Dr. WHIPPLE. No comet is known with certainty to have come within the moon's distance; so the chances are extremely small.

Mr. McDONOUGH. What is the orbit of Halley's Comet?

Dr. WHIPPLE. That has about a 75-year period. The minimum solar distance is somewhat smaller than the earth's distance from the sun. So that it comes inside the earth's orbit but not particularly close to the earth.

Mr. McDONOUGH. Is there any boundary line to this space as we know it?

Dr. WHIPPLE. That is an extremely difficult question. The atmosphere becomes less and less dense as one goes farther and farther out in space, but starting in the other direction we know that there is an appreciable quantity of matter in space, a minimum of 100 hydrogen atoms per cubic centimeter. Thus where the atmosphere stops and interplanetary space begins is very difficult to define.

The only measurement that I have heard about that might give you a definition is the distance to which the earth's magnetic field seems to control matter. The material appears to rotate more or less with the earth to about 50,000 miles, a very rough value but perhaps the right order of magnitude.

Mr. McDONOUGH. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. I have no questions, but would you put in the record regarding the cooperation of yourself and the Astrophysical Laboratory, your institution in Cambridge, in the IGY so that we would have a pattern for that in the record?

Also I would like for the record any kind of contract or agreement you have with the National Science Foundation, plus the overall master agreement for the IGY. I would like their overall type agreement that set up the IGY.

Dr. WHIPPLE. With regard to the current cooperation of the Smithsonian Astrophysical Observatory with the efforts of the International Geophysical Year, I have earlier in this testimony outlined the nature of the satellite-tracking problem that we contracted to execute. It is limited to optical observations of artificial earth satellites and we have included visual type observations and photographic observations with precision cameras at 12 stations over the world. The contractual arrangements and various legal aspects of our effort are attached.

(Sample of letters of grant follows; other data is on file with the committee.)

NATIONAL SCIENCE FOUNDATION

OFFICE OF THE DIRECTOR

Washington 25, D. C.

JUNE 13, 1956
Grant No. Y/30.5/145

Dr. LEONARD CARMICHAEL,
Secretary, Smithsonian Institution,
Washington, D. C.

DEAR DR. CARMICHAEL: I am pleased to inform you that the sum of $125,000 is hereby granted by the National Science Foundation to the Smithsonian Institution, for "Initiation of optical tracking system for the International Geophysical Year earth satellite program," under the direction of Fred L. Whipple, Astrophysical Observatory. This grant will be paid on or about 2 weeks from the date of this letter, in full.

It is a condition of this grant that it may be revoked in whole or in part by the Foundation after consultation with the principal investigator and the grantee except that a revocation shall not affect any commitment which, in the judgment of the Foundation and the grantee, had become firm prior to the effective date of the revocation; and that funds not committed by the grantee prior

to the conclusion of the work contemplated under this grant shall be returned to the Foundation.

It is a further condition of this grant that disposition of domestic patent and other rights in any inventions or discoveries made or conceived during performance under this grant shall be the responsibility of the grantee; that disposition of foreign patent and other rights to any such invention or discovery shall be determined by the United States Government; that the grantee shall give the Foundation reasonable notice of application by the grantee or other person or institution for a foreign or domestic patent on any such invention or discovery; and, that upon issue of a domestic patent on any such invention or discovery, the patentee shall grant the Government an irrevocable, royalty-free, nonexclusive license for use of such invention or discovery for governmental purposes.

It is also a condition of this grant that title to all equipments procured with these funds shall vest in the grantee, provided, however, that such equipments must be used in accordance with approved plans for the forthcoming International Geophysical Year program, and, provided further, that following completion of the International Geophysical Year program, final disposition of these equipments shall be determined by the Foundation after consultation with the grantee.

The Foundation desires that this grant be administered in general accordance with the Foundation's policies for research grants, insofar as applicable thereto, as stated in "Grants for scientific research," April 1955; in accordance with "Reporting requirements for grants made in support of the International Geophysical Year," and, in conformity with other understandings reached between the Foundation and the grantee relating to this grant.

Please acknowledge receipt at your earliest convenience.

Sincerely yours,

C. E. SUNDERLIN, *Acting Director.*

SECTION A

APPLICATION FOR RESEARCH PROJECT FOR THE U. S. INTERNATIONAL GEOPHYSICAL YEAR PROGRAM

If approved, Smithsonian Institution will accept responsibility for administering a National Science Foundation grant for the USNC-IGY project described in the attached "Summary USNC-IGY Research Project Budget Estimates" which represents the present estimate of funds required to discharge the responsibility and the enclosed "Information on Research Project" which provides details of the proposed research plan and other pertinent data.

Title of Project: Initiation of Optical Tracking System
IGY Project Number: 30.5
Total Amount of Project: $125,000.00
Name and Address of Institution: Smithsonian Institution, 10th & Independence Avenue, NW., Washington 25, D. C.
Name, Title and Personal Signature of Project Director: Dr. Fred L. Whipple, Director, Smithsonian Astrophysical Observatory
Name, Title and Signature of Official Authorized to Sign for Institution: Dr. Leonard Carmichael, Secretary, Smithsonian Institution

Date: Jan. 26, 1957

SECTION B

INFORMATION ON RESEARCH PROJECT

This information should be prepared in narrative style, following the outline set forth below. A copy of this information should be attached to each of the six copies of this form being submitted to the U. S. National Committee.

1. *Project Information:*
   - 1.1 *Project Title:*
   - 1.2 *IGY Project Number:*
   - 1.3 *Name and Business Address of Individual to be Contacted for Detailed Project Information:*
   - 1.4 *Project Description:*
     - 1.4.1 *Describe plan of operation:*
       - (a) *Preliminary work:* List equipment to be built or procured; facilities to be procured and erected; explain plans for personnel acquisition and training; shipping plans (indicate where plans are uncertain because of unsolved problems); give time schedule for this work preparatory to commencing measurements July 1, 1957.

(b) *Measurement program:* Give location of measurement stations; describe facilities, equipment, other material, etc., which will be contributed at no cost to the project; describe briefly method and objectives of measurements; indicate plans and estimated schedule for closing out measurement station after December 31, 1958.

(c) *Data reduction and publication (only for data reduction centers):* Indicate extent to which you expect to participate in this part of IGY program; describe briefly any special techniques planned for data handling and any unsolved problems; indicate number of personnel and type (e. g., professionals, technicians, statistical clerks, etc) required; state where reduction work will be done; list anticipated donated facilities, space, personnel, etc.; estimate time required for data reduction and for publication.

2. *Related Work:*

2.1 Describe briefly prior history of your institution in this field.

2.2 Describe similar work at your institution currently under way; indicate plans for integrating this work with the IGY program; indicate, if possible, source of funds for this collateral work.

3 *Biographical Information*—Provide the following biographical information for the principal project director and other senior project investigators:

3.1 *Current Position* (give title and describe briefly)

3.2 *Prior Experience* (give title of and describe very briefly each principal position)

3.3 *Degrees Held and Institutions Conferring*

3.4 *Major Publications*

3.5 *Professional Affiliations and Honors Awarded in Field of Specialty*

Section "b" project 30.5

1. *Project Information*

1.1 Project Title: "Initiation of Optical Tracking System"

1.2 I. G. Y. Project Number: 30 5

1.3 Name and business address of individual to be contacted for detailed project information: Dr. Fred L. Whipple, Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, Mass.

1.4 *Project Description*

1.4.1 (a) (b) and (c)

This project is a continuation of the preliminary phases as commenced under Project 30.3 and includes the development and emergency partial purchasing of and contracting for telescope cameras, parts, glass dishes, back-up plates, and other special equipment, and additional research and designing work, including developmental work for image-tube presentation prototype.

2. *Related Work-*

2.1 The solar radiation studies of the Smithsonian Institution in the astrophysical field have been publicized all over the world for a period of sixty years. It is felt that further comment here would be superfluous.

3. Biographical information: (See sheets submitted separately)

SECTION C

SUMMARY USNO-IGY RESEARCH PROJECT BUDGET ESTIMATES

(Provide complete detail for each indicated fiscal period. Specify dates by which funds for equipment and supplies must be received, and, for fiscal year 1956, dates and purposes for which other types of funds are required. If funds have already been received, identify in first column under appropriate budgetary items and include details. *Please submit on separate sheets six copies of budget statements, following this same form, for each station which you plan to install and/or operate.*)

	Through June 30, 1956	July 1, 1956 to June 30, 1957	July 1, 1957 to June 30, 1958	July 1, 1958 to June 30, 1959	Total
1. *Personal Services* (Indicate types and numbers of personnel, annual salary rates, percent of time to be spent on project Include separately a line item for retirement, social security, etc.); None; services of the Director (Whipple) and Associate Director (Hynek) are paid from regular Smithsonian Institution funds.					
2. *Travel* (Indicate nature and applicability): None					
3. *Shipping and transportation* (Specify) None					
4 *Communication*: None					
5 *Printing and Reproduction* (Indicate nature) None					
6 *Expendable Equipment and Supplies* (Indicate in general terms the types of equipment and supplies required)					
Power supply system for crystal clocks (batteries)		$2,396			
Optical glass and design of smaller items		5,000			
7. *Equipment (Permanent)* (Itemize)					
Procurement of 32 units of external glass discs for satellite tracking cameras at $1,822 each (Fish-Schurman Corporation)		58,304			
Procurement of back plates for satellite tracking cameras (estimated)		14,000			
1 clock recording mechanism and components (pulse gates)		5,000			
8. *Other* (Specify)					
(a) Optical design to optimize Schmidt optics		12,000			
(b) Crystal clock presentation system prototype		2,000			
(c) Development of contingency type contract for image-tube presentation prototype		10,000			
9. *Total Direct Costs*		108,700			
10. *Allowance for Indirect Costs* (only if applicable, and not to exceed 15 percent of total direct costs) Computed at 15%		16,300			
11 *Subtotals*					
12 *Data Reduction and Publication* (preliminary estimate; include indirect costs, if applicable)	xxx	xxx			
13. *Grand Total*		$125,000			

In summary, the United States National Committee of the International Geophysical Year under the auspices of the National Academy of Sciences recommended to the National Science Foundation that we be awarded a grant for the execution of this program through the period of the International Geophysical Year and extending on for 6 months beyond it to June 30, 1959. We are extremely attentive to recommendations by the National Committee of the IGY through their technical panel on the earth satellite program

and its working group on tracking and communication. The data and results that we obtain are transmitted to the National Committee in advance of publication and release.

Communication with IGY groups in other countries is conducted formally through the national committee but considerable scientific comunication is carried out on a scientist-to-scientist basis with those in other countries. The Moonwatch visual program has involved excellent cooperation with the IGY committees and individuals of a number of countries, excepting the U. S. S. R., which has its own Moonwatch program modeled almost precisely upon ours. Nine of our twelve tracking stations are on foreign soil and we have found admirable cooperation from the scientists of these countries. We feel that our programs are of real benefit in encouraging astronomy and science broadly in a number of these countries.

The satellite tracking program has involved a relatively large effort compared to the normal operations of the Smithsonian Astrophysical Observatory. A number of our scientists have been required to help out, on a temporary basis, with the unexpectedly rapid developments in the tracking program arising from the sputnik launchings in 1957. The program must continue for several years to complete the scientific research planned as the geodetic results cannot be obtained except from satellites of considerable lifetime observed for a period of a year or more.

Our specially developed cameras are the only ones in the world, to my knowledge, that have yet obtained precision photographs of the United States artificial satellites in orbit. I hope that these comments will clarify the questions with regard to our cooperation with the IGY.

The CHAIRMAN. Mr. Keating?

Mr. KEATING. I have nothing except to sound a warning about this telepuppet. As nearly as I can tell from what you say, it may have all of us out of a job.

Dr. WHIPPLE. There must be some person to manipulate each one of them. It will only put half of us out of a job.

The CHAIRMAN. Mr. Ford?

Mr. FORD. May I add a footnote to what Mr. Keating has said?

Some of us being put out of a job might please a lot of people.

In your comments earlier, Doctor, you mentioned that, in effect, this new agency should have what we consider to be no-year funds. Once the obligational authority is made available, it should be made available until obligated and expended.

That is done as far as the military is concerned in research and development and procurement and 1 or 2 other areas. Does your agency or subdivision have such authority now?

Dr. WHIPPLE. No.

Mr. FORD. Is that a handicap to the good prosecution of your program?

Dr. WHIPPLE. Yes, I should say so. In the present satellite-tracking program we have need of more men, for example, in celestial mechanics. There is a limited number of those people. We cannot give high-level people promise of a long, continuing position, or even 2 years for that matter. It makes it very difficult for us to import people who might be extremely valuable to us.

The CHAIRMAN. This bill provides for such an appropriation as I understand it.

Dr. WHIPPLE. I gather it does. I want to commend it in that respect.

Mr. FORD. Section 9 appears to give such authority, Mr. Chairman. I believe the wording is more or less identical with that in the various military appropriations. I think it is highly necessary.

The CHAIRMAN. Mr. Feldman?

Mr. FELDMAN. I have some questions that I would like to submit, Doctor. They will be in the record, and will you answer them when we send the record to you for editing?

Dr. WHIPPLE. Certainly.

(The questions referred to are as follows:)

1. Can you comment on the future prospects for astronomy once we are free of the distortions of the earth's atmosphere?
2. Is there any earthbound substitute for the clarity a satellite-mounted telescope might give us?
3. Can you explain what the Maser device can mean to astronomy?
4. Do you feel the hazards, such as meteorites of space will seriously limit the transport of men in space ships?
5. Could you comment on Dr. Hagen's point that identifying all satellites in the sky is important both to astronomers and to national defense?
6. Do you think meteorite erosion will end Vanguard's life sooner than 200 years?

(Material referred to follows:)

In answer to the second question there is no earth-bound substitute for the clarity that a satellite-mounted telescope might give us. There is, however, a possibility of obtaining the full resolving power of a telescope to separate the small details of planetary surfaces or of double stars in space by means of balloon-mounted telescopes. Some work has been done on this already and for a great many years it appears that the balloon-mounted telescope will probably be the least expensive means of obtaining the highest quality images of fine angular details in space. It is also possible that the balloon-mounted telescope will represent the least expensive method of studying space in the infrared, but not in the radio region, the ultraviolet, the X-ray region or the possible gamma-ray region.

The first question, "on the future prospects for astronomy once we are free of the distortions of the earth's atmosphere", can now be answered. Putting a telescope in space may revolutionize astronomy as much as the invention of the telescope itself. The radiations from stars and from interstellar matter range over some 60 octaves (each octave being a factor of 2) in the electromagnetic radiation spectrum. Optically we can observe only a little over one octave with about another octave available in certain regions of the infrared. In the radio frequencies a few octaves are available and are now used in radio astronomy. Nevertheless most of the radio range is reflected and absorbed by the earth's ionosphere and consequently cannot be used for studies of the universe. Hence the major advantage of a telescope mounted in space will be to study the universe in ultraviolet radiation, in X-ray radiation, possibly in gamma-ray radiation and finally in a very large section of the radio region. Furthermore in space we will be able to study directly the high velocity particles that are shot out from stars and possibly from great masses of gas in space. At greater and greater energies these particles link into what we know as cosmic rays and there again we can study the cosmic rays directly instead of a mixture of them coupled with a huge number of secondary effects arising from their striking the earth's upper atmosphere.

We do not yet understand how the violent storms on the sun arise, nor do we understand the real cause of the sun's corona. Solar emanations of both high-velocity particles and far ultraviolet radiations including X-rays affect the earth's magnetic field, the ionized layers of the atmosphere, (that make possible long-range radio communication) night sky light, the aurora borealis, and a number of manifestations on our planet. Observations from space will therefore give us information about the sun that will be directly applicable to an understanding of the sun and an understanding of these many related

phenomena on the earth including possibly the weather. We do not yet know for certain the origin of cosmic rays and I believe that observations of the solar universe and the interstellar gas from above the earth's atmosphere will be required to clarify this basic problem. The origin, birth and death of stars are all only incompletely understood and direct observations in these inaccessible radiation regions will give us clues that I believe will lead toward answers to these problems. Furthermore we have the major features of the universe at large, the great galaxies of stars, their structure, origin, and evolution, intensely hot regions in space whose origins in some cases are uncertain. Space research probably will lead to completely new concepts and possibly new physical laws when we study such major phenomena as the collision of external galaxies. Knowledge gained from outside the atmosphere should lead us far on the road to an understanding of the universe, or at least many more limitations on tenable theories for the origin of the universe.

The physical exploration of the moon will, I believe, provide us with a clear-cut understanding of the origin of the earth since the clues on the moon will be undisturbed as compared to those on the rapidly changing earth's surface. The very fundamental problem of life on other planets will be much clarified by the physical exploration of the nearby planets, Venus and Mars.

Without a long article on the subject this account gives some idea of our expectations for astronomy from a space station. Already we have seen from the cosmic ray measures of the American Explorers that surprises are in store for us in space. I am certain that the most valuable results will be those that are unexpected in character; and this applies not only to the nature of the universe but to the technological developments involved in space explorations.

The Maser device will increase the sensitivity of radio receivers by a large factor. This means in astronomy that radiotelescopes on the earth (or in space at the frequencies that do not penetrate the ionosphere) can be made many times more sensitive than those in common use today. This revolutionary device will, therefore, increase the value of radio measurements by a large factor and enable us to study sources of radiation that are weaker by this same factor. Thus the advantages in radio astronomy will be extremely great and we expect that new areas of study will be opened up by the "Maser."

With regard to the hazards of space, such as meteorites, I feel that they will increase somewhat the cost of space exploration, but will not seriously limit the transport of men in spaceships. In other words, the hazards of space can be determined with precision by means of unmanned space vehicles, so that design elements in actual manned space vehicles can reduce these hazards to minimum values compared to the major hazards of launching, maintaining a livable environment, and reentry. Because of the hazards, space vehicles may be heavier and provided with special devices which will increase the cost per pound of payload. But I do not see a real deterrent to manned space travel in the natural hazards that we can now anticipate in space.

With regard to question 5, I have already, in my testimony, reported on Dr. Hagen's point that identifying all satellites in the sky is important, both to astronomers and the national defense.

With regard to meteorite erosion, it is difficult to estimate just how vulnerable the Vanguard's satellite will be to this process. I estimate that in 200 years the erosion will not amount to much more than a thousandth of an inch, on the average, over the surface This should not be serious, but there is the real possibility that larger meteorites will strike a vulnerable connection wire or element in the satellite and thus end its usefulness. My very rough guess is that the chances of meteoritic collision ending the radio usefulness of the Vanguard satellite is more or less 50–50 in 100 years. The etching of the windows by meteoritic dust may reduce the efficiency of the solar batteries in a decade or so, but should not render them useless These guesses could easily be in error by a factor of more than 10.

The CHAIRMAN. Doctor, these tracking stations you refer to; will you go into more detail on them?

Dr. WHIPPLE. Yes. There are 12 of them located around the earth; for example, in the Northern Hemisphere—New Mexico, Florida, Spain, Iran, India, Japan, Hawaii, and Curacao; in the Southern Hemisphere—South Africa, Australia, and 2 in South America.

They have a novel and extremely difficult optical system in the tracking camera, so that we have, indeed, been able to photograph

both the Explorer I and Vanguard. The Explorer I, optically, is a 6-inch tube about 50 inches long, painted white, which we have been able to photograph at 700 miles' distance. Each station comprises, also, a precision clock, accurate to about a thousandth of a second, and the time is photographed on our film, along with the satellite photographs to be read to one ten-thousandth of a second.

The CHAIRMAN. Also, you made reference to the value that might flow in the future from the money spent that would redound to the peacetime advancement and so forth. Will you elaborate on that when you are editing your testimony?

Dr. WHIPPLE. Yes, sir. I have already mentioned the direct commercial values to the peacetime world of the meteorological advances that should be possible from artificial earth satellites and, also, the incidental development of remote-controlled "telepuppets" as a high probability. Almost every one of the technological requirements for space exploration can readily be shown to lead to practical everyday uses in our modern world.

There is no question in my mind that the developments in miniaturization required specifically for space science will in fact accelerate valuable applications in everyday life. Many of these developments will certainly be included in aircraft and, probably, in automobiles, as well as in household devices as the techniques of their manufacture become more developed. This will mean an increase in reliability, along with a great reduction in volume and power consumption for a multitude of such devices.

Developments in high-temperature-resistant materials for rocketry will certainly find applications throughout our industry where fuels, powers, and high temperatures are involved in practical applications.

The guidance and control requirements for space vehicles will certainly be of value in a multitude of practical instrumentation and manufacturing techniques.

The development of reliable controlled rockets and reentry techniques for manned space vehicles will almost inevitably lead to rocket-type vehicles for point-to-point rapid transportation on the earth. Hence, no point of the earth will be more than 2 hours away from any other point for actual travel. We have seen this type of development in the aircraft industry, and I have no question that it will occur in the rocketry industry.

The development of special fuels for rocket purposes will become applicable for peacetime uses. Particularly, a demand for lightweight, long-lived energy sources necessary for ordinary power requirements in space exploration will certainly be of great value in our everyday life. The impetus of the developments necessary for space exploration will greatly hasten the day when these compact, long-lived power sources will become available. We have already seen the impetus of the IGY satellite program in the development of the solar batteries.

In the biological areas, I am not particularly competent, but can readily see where a solution of basic problems in maintaining man in space may have application to everyday life, particularly to utilization of land areas that are now considered as waste for food consumption or for habitation. For example, hydroponic gardens, utilizing solar radiation and little power, must be studied extensively so that man may, possibly, survive indefinitely in spact without the need for an artificial power source. Developments along these lines could

easily find applications in utilizing desert areas for habitation and food supply.

The space program will almost certainly accelerate research in the biological effects of cosmic radiation and X-radiation and, also, in areas involving the effects of exhalation waste on human metabolism, not to mention psychological factors of isolation and the like.

I have not attempted to be complete in listing such byproducts of space exploration, but wish to indicate the nature of the progress that may be accelerated by such a program. Again, I reiterate the experience of the past when a new research area is opened; the greatest developments and the most important results obtained from the research are practically always the unexpected.

The CHAIRMAN. Any further questions? Doctor, we appreciate very much your appearance and, also, your patience. This is a very serious assignment which has been given to us. You can see, by the fact that we are working as late as we are, that the members of the committee are taking it very seriously. For myself, as chairman, and for the members of the committee, I express to you our sincere thanks.

Dr. WHIPPLE. It is a pleasure, indeed, sir.

The CHAIRMAN. The next witness is Dr. H. Guyford Stever, associate dean of engineering and Chairman of the National Advisory Committee on Aeronautics, Special Committee on Space Technology. We shall be very glad to hear from you, Doctor.

STATEMENT OF DR. H. GUYFORD STEVER,[11] ASSOCIATE DEAN OF ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CHAIRMAN, NATIONAL ADVISORY COMMITTEE ON AERONAUTICS, SPECIAL COMMITTEE ON SPACE TECHNOLOGY

Dr. STEVER. Thank you, sir. In the first place, may I make one correction in reference to your introduction of me, and I think you, Mr. Chairman, will appreciate it. I am the associate dean of engineering at the Massachusetts Institute of Technology.

The CHAIRMAN. That is correct. Pardon me for making that error, because we all know about the MIT, and I have a very friendly relationship with President Killian, and I met General McCormack and had lunch with him in Boston not long ago, Hal Weber, and others.

Dr. STEVER. Mr. Chairman, I have a few notes, but, for the sake of brevity, if I have your permission, I will not read them. I still would like to make a few of the points in my notes in a very brief manner. I would like, also, to introduce my notes into the record.

In the first place, it seems to me that the most important consideration we have as we lay out our Government's venture into space, as this committee is doing, is to recognize that this is an activity which will have a continued existence.

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[11] Stever, Horton Guyford, educator; b. Corning, N. Y., Oct. 24, 1916; s. Ralph Raymond and Alma (Mott) S.; A. B., Colgate U., 1938; Ph. D., Cal. Inst. Tech., 1941; m. Louise Risley Floyd, June 29, 1946; children—Horton Guyford, Sara Newell, Margarette Risley, Roy Risley. Staff mem. radiation lab. Mass. Inst. Tech. and instr. officers radar sch., 1941–42, asst prof., 1946–51; asso. prof. aero. engring., 1951—; exec. officer guided missiles program, 1946–48; on leave as chief scientist, USAF, 1955—; cons. aero. industry. Mem. secretariat guided missiles com. Joint Chiefs of Staff, 1945; sci. liaison officer London Mission, ORSD, 1942–45; mem. guided missiles tech. evaluation group Research and Development Bd., 1946–48, mem. sci. adv. bd. to chief of staff USAF; mem. steering com. of tech. adv. panel on ordnance to Asst. Sec. of Def. Recipient President's Certificate of Merit, 1948. Episcopalian. Fellow Inst. Aero. Scis. (asso.), Am. Acad. Arts and Scis., A. A. A. S., Am. Phys. Soc.; mem. Phi. Beta Kappa, Sigma Xi, Sigma Gamma Tau. Contbr. profl. publs. Home: 36 Fairmont St., Belmont 78, Mass.

I think we have to realize that man's interest in this field goes back in time a lot farther than sputnik and existed long before our generation of science. In fact, man's interest in space goes back to some of the greatest minds centuries and centuries ago. For example, a member of a great senate long ago, Cicero, wrote an article on travel into space.

I would like to refer you to his Die Somnium Scipionis for some interesting thoughts. It is indeed a very long-term activity that we are pointing toward. I am pleased in noting in the questions of the committee that you are taking the long-term aspects of space technology very seriously.

I am concerned with the publicity that we in this field are getting; it pays much too much attention to the short-term aspects, for example, the spectacular shots of the first passenger in space, or the first instrument landing on the moon. The public may think that this is the only important aspect.

Actually, the phases of space technology that have paid off already are well known to you. In the military field there is an unquestioned payoff and most of us who know this field believe that the progress will continue for a long time.

Also, you have had distinguished scientists here who have given you their comments about the scientific benefits of a space program. However, if you go beyond the military and scientific fields, there are some other uses of space in which we have not done so well to date. For example, when the NACA Special Committee on Space Technology helds its first meetings, we found that most of the ideas that had been developed in this country pertained mainly to the military and scientific uses. Still, we see some unsupported engineering applications which can do us some good in our daily lives.

The communications relay stations and the weather prediction stations on satellites have already been mentioned in testimony to this committee. I think we should develop these much more rapidly. Of the hundreds of proposals that I know about in the space-flight field, a very large number of them are pointed toward short-term spectacular jobs such as sending some instruments to the moon, sending a man to the moon. Very few of them are pointed toward the long-term program which will result in good for mankind. I believe that we have to look at this unbalance very carefully. Certainly in the NACA Space Technology Committee activity with which I am associated, this will be one of our principal objectives.

Much has been said about putting man in space. I am referring here not to the short-range flights that have been mentioned by Dr. von Braun, but flights with a man in a satellite or a man in a moonship. It is my belief that we have a long way to go before we really are going to be able to accomplish this.

We have a lot of experiments to perform before we know whether it will be possible to get the man safely out and safely back. I say "whether it will be possible." In the long run, I am perfectly confident that it will be possible, but we have a lot to do before we can actually achieve it.

Also, as has been pointed out, we still have a question as to the reason for a man in space.

Let me talk a little bit about the kind of activity that I think has to go into a space program. In the first place, we have already started

some very good scientific experiments. You have heard this described in detail and I am confident that that part of it will proceed with good success.

This type of work is carried out by the scientific laboratories of the country; that is, Government laboratories and academic laboratories. A lot of its success, however, depends upon not only scientific achievement but engineering achievement in the devices which take the scientific instruments out into space.

This engineering achievement is also technical; many people call it scientific, but I think of it as an achievement of large engineering development laboratories within industry which are available to the Government.

There is another somewhat different technical activity which involves laboratory work, not on the scientific experiments and not on the vehicles themselves, but on the components which will eventually lead to a greater capability in space-flight vehicles in the future. I think, for example, of the sort of experiments that are being done in atomic energy for future propulsion, such as ion propulsion, nuclear propulsion, and possibly photon propulsion.

In any organization to handle the national space flight interests, scientific and engineering abilities must be tapped. Men with these different abilities are collected in a number of different places in this country, in Government, in industry, and in academic institutions.

I would like to state that I favor the organizational proposal which uses NACA as the nucleus of a new organization. I can make complimentary remarks about NACA because I have never actually worked for them. In fact, this space technology activity is the first activity of mine in which I have been an adviser to them. Still, I have recognized for some time that the NACA was a fine working group. They have already entered the space technology field; they have also worked in closely related aeronautical fields.

In the long run, there will be a continuous spectrum of science and engineering, starting covering low-speed flight in the lower atmosphere and continuing right up through higher and higher speeds to higher and higher altitudes.

One will not be able to distinguish where aeronautics cuts off and astronautics begins. I do not believe that responsibility can be divided early amongst two or more agencies.

I would like to see an organization which encompasses all the flight problems from zero altitude and zero speed up to, hopefully, an infinite altitude and infinite speed.

The CHAIRMAN. In practical effect, Doctor, will that not reside outside of the field of atomic energy? Is that not bound to be the practical result if an agency is established?

Dr. STEVER. If the Agency is set up according to this bill I believe that is correct.

The CHAIRMAN. In other words, we are projecting our minds and applying the law of natural consequence.

Dr. STEVER. There have been suggestions about an agency which deals with space only, and another agency which deals with atmospheric flight, in other words, the continuation of NACA. I do not believe that these subjects can be separated easily.

Mr. FULTON. I want to compliment you, first, for being the only scientist who has discussed this as a practical study, photon propul-

sion, and second, to compliment you on being the only scientist who has referred to an infinite speed which greatly exceeds the speed of light.

Dr. STEVER. Thank you. One other point I would like to make is that the military applications of space technology, the scientific applications, the engineering applications for nonmilitary purposes, all will use the same scientific and engineering background.

I think that the organization that is set up to handle space must have a capability of working with the military. NACA has already established very fine working relationships there. They also have the capability of working with the other organizations such as the National Science Foundation and the National Academy, which concentrate on the scientific side of these problems.

I think it is important, as you have indicated you will do in this bill, to establish a new agency based on NACA because, as I have already mentioned, the Agency must tap resources outside of Government. Industry and the academic institutions must be brought in. This must be done by contract and, by and large, the NACA has not had a contract program of the order of magnitude that I expect will be necessary here.

The CHAIRMAN. Doctor, I know the committee and I will appreciate it if you will carefully look over this bill and make suggestions where it can be strengthened along the line of divisibility. Not that they will recognize it right away, but the authority will be there.

Like yourself, I cannot see how you can divide this activity, this whole field. I can see immediately, starting out, the concentration on certain levels, but I do not see where there can be that divisibility and there must be the merging, the melding, and I will feel happy if the authority is in there for the future when that situation arises.

Dr. STEVER. I will certainly look at it from that point of view and make comments on it. I would like to make one other point, which is more general than space technology, but still it applies.

I believe it is important in the planning stage of this activity that we are now in to bring a large number of organizations in to think over the problems and to decide upon a program. I believe that the organization that is established must, however, after the program is selected and after the support is given, decentralize its authority and responsibility.

I think we are making a mistake in this country, as we elevate our science and our technology and our technical questions to higher and higher levels in Government, in bringing detailed direction to the highest levels.

I would hope that the higher levels of Government continue in the broad policymaking and the planning functions, but that authority and responsibility for doing the jobs must be passed down to the working technical level.

Somebody has mentioned the many levels of decision which Dr. Hagen had to go through. We can respond in our technical programs in this country much more rapidly than we have in the past provided we decentralize authority and responsibility after our major plans and programs have been made.

Mr. McDONOUGH. You mean have a freer hand?

Dr. STEVER. When the decision to go ahead with a project is given, I think the working level should have a free hand. The project leader should stand or fall on his accomplishments. In fact, I believe that

occasional failure because we picked the wrong man is far better than the delay we now get in all our projects by too detailed checking upon him.

I do not think that the project leader should have a free hand in the planning and the idea stage. At that time ideas must come from every echelon, high and low. From my own observation of the NACA leadership, I believe they appreciate this requirement of decentralized operation and centralized policy in getting a scientific or technical job done.

Mr. McDONOUGH. Do you think Russia has given that freedom to their scientists?

Dr. STEVER. I think they have a considerable element of the delegation of responsibility and authority at the same time. They also have one thing we do not have, which is a very effective way of punishing somebody if he does not come through.

Mr. McDONOUGH. He is free as long as he produces.

Dr. STEVER. That is right.

Mr. FULTON. For the record, may I say that Tupelov recommended your program to the Russian Government in 1928, which was then adopted, so there are now over 770 scientific institutes operating in the Soviet Union.

Dr. STEVER. Sir, that is a summary of my prepared remarks.

The CHAIRMAN. Mr. O'Brien?

Mr. O'BRIEN. I would like to ask one brief question, primarily because the Doctor emphasized MIT.

Do you think that we have, including some of the witnesses before this committee, overemphasized the weakness of our science posture in this country as compared with Russia? Are we as badly off in our schools?

You are from an institution which gets pretty much the cream of them. Are they still coming in? Is there an interest in science?

Dr. STEVER. Sir, I am very glad to be asked that question because I would like to go on record to say that I think we are far superior in our overall schooling system to Russia. I do think that Russia, with a very lopsided system, has concentrated on science and technology and there they are doing well.

I hope that we never create the Russian unbalance in our school system. I would point out, however, that science and engineering are subjects which change very rapidly, and it is very easy for a good schooling system like ours to get behind, especially at the lower grades. I am very pleased that the educational input from this so-called sputnik crisis resulted in an overhauling of that aspect of our education.

Mr. O'BRIEN. That leads to my second question.

I would hope that, too, but do you not think the very fact that we are in this space era now, whether we want it or not, is going to lead to a tremendous increase in the interest in science on the part of young people?

I have noticed right here in Congress, here is a group of pretty busy people. They have been sitting here morning and afternoon whenever they could and they are fascinated by the subject. I just wonder with all these tremendous possibilities that you and other witnesses have opened up—possibilities from a practical viewpoint, a job if you will, perhaps celestial mechanics—do you not think there will be a natural turning toward science and engineering by young people who will see the glamor and fascination of this new era?

Dr. STEVER. Yes, we have already noticed that.

The CHAIRMAN. We also have the job of accomplishing the future problem that faces us in preserving the fundamental ways of life we believe in; in other words, to have it serve us rather than master us, whatever the future might unfold. Is that right, Doctor?

Dr. STEVER. Yes, sir. I would say along that line that I do not want to be led into a space program or a schooling program by the Russians We have lots of good ideas of our own on both of these subjects. Now, we can be spurred on in our efforts by the Russians. We can be given a push to make sure that we go a little faster, but I do not believe that I would adopt the Russian approach either for our school system or for our space program.

We have some good long-term reasons for having our own space technology program independent of what the Russians are doing, and I have outlined them here. I think there is no question but what we are in some aspect of competition with Russia with respect to this, but I do not want to follow them.

I would make the same remarks with respect to our schooling system; I do not want to adopt the Russian schooling system. I would like to improve our own and not give up some of the things we want.

Mr. FULTON. For the future which has just been brought up, could you give us possible various industrial developments so we could insert them in the record? That is, new industries and new scientific practical application that you can see which would be of benefit to the economy in such space programs and space research?

Dr. STEVER. Yes, sir.

The CHAIRMAN. Mr. O'Brien?

Mr. O'BRIEN. Mr. Fulton has taken care of my final question. In connection with your reference to spectacular stunts, am I correct in assuming that you mean that eventually you will get to the moon but that we should not devote all our energies in getting to the moon, we should learn a great many things on our way to the moon?

Dr. STEVER. Yes, sir.

Now, can I make just one addition to that? I have seen many proposals which not only would take all the money we have for space technology but would take all the money we have for defense of the country, and most of them are for what I have called the spectacular type of flight.

We have a good deal of good, hard, engineering and scientific work to do and we can do it in a sound way and still reach these objectives. I think we have to concentrate on the right things.

Mr. O'BRIEN. Thank you very much, Doctor.

Dr. STEVER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Metcalf or Mr. Natcher.

Mr. NATCHER. Doctor, as I understand, you are of the opinion that the two agencies should be patterned after the NACA but it should be on more of an expanded basis with certain contractual rights and other duties to perform which, of course, the NACA does not have.

What part, if any, should the military have in the new agency?

Dr. STEVER. Sir, in the first place, I think the agency should not be under the control of the military. Still, the new agency must have a very good working relationship with them.

Let me take one technical problem that is only touched upon occasionally. This is the area which we, in the NACA Space Technology

Committee, have referred to as surveillance. It involves tracking our own satellites which are friendly satellites, our own space vehicles, which are friendly, and into which we can put radio beacons, and so on; this technical problem of tracking friendly vehicles with beacons is not too difficult because it is a one-way transmission of energy. But if we are involved in the defense of our country there will be lots of vehicles, such as enemy satellites, which will be inert. We will not be able to track them by self-contained radios. We will have to use radar or other schemes. Immediately the surveillance problem of this space technology agency we are talking about gets linked to the surveillance problem which the military people have. So there must be a very close working relationship on surveillance.

A second area of overlap is in rocketry. It does not make sense for this country to develop different rocket motors which often are quite similar technically both for nonmilitary and military programs. There must be an exchange of equipment. I think this can be done on a relationship which is not a controlling relationship but a mutual-agreement relationship.

In the third place, the military organizations which will develop better ballistic missiles, military satellites, and so on, are going to depend on the same background science and technology as does the civilian space agency. Their technical interests then will overlap. The new agency can help the military a great deal by giving them information and new techniques. The relationship must be very close but I hope that it is not one of control.

Mr. NATCHER. Thank you, Doctor.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Doctor, do you have any concern with reference to the littering up of space with too many satellites?

Dr. STEVER. I do not have a concern with respect to collision because it is already littered up with comets, asteroids, and meteors.

But I do have a concern with respect to the surveillance problem again. If we get too many vehicles out in space, pretty soon we will have such a very difficult job of keeping track of them and of distinguishing the ones we know cannot harm us from new ones that might be launched in a military venture against us.

I think if we have this space filled up there with lots of vehicles, a surprise attack by enemy ballistic missiles will be much easier to accomplish.

Mr. SISK. You think it then would enhance the possibility of a real surprise attack?

Dr. STEVER. Yes, sir.

In this respect I think we are more susceptible to surprise attack than the enemy because they would be the aggressor.

Mr. SISK. That is all.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. I appreciate your appearance here and the information you have given us, Dr. Stever.

Is not the development of rockets principally a Government function now because it is not a commercially feasible project for private industry?

Dr. STEVER. The larger rockets are very expensive to develop. So far, the Government, mostly the military, has been the only user and,

more pointedly, the scientists have taken advantage of military developments to accomplish some of their experiments.

There may be a time in the future when the development of rockets for nonmilitary purposes will become a sufficiently large business to become a profitable one by itself.

I would say this, however: I think that the rocket industry can get joint support from the military and the new agency and so will prove to be a profitable business venture.

Mr. McDonough. Well, in addition to weather reconnaissance, there is the communications advantage.

Dr. Stever. I am sorry, I must have missed the sense of your question.

You are now asking whether, in these scientific and engineering applications for nonmilitary uses, is there a big production volume that will prove profitable to industry.

Mr. McDonough. Yes.

Dr. Stever. I do not think that it is a volume business in the same way that the ballistic-missile business is. This is one of the aspects of nonmilitary space technology that is going to be very hard to get around. Until it becomes a volume business it will be difficult to get the developments we want unless we put Government money into it.

Mr. McDonough. If we had satellites in orbit and relay stations, we could speed up our communications system much more rapidly than we have now, worldwide?

Dr. Stever. Yes, sir.

Mr. McDonough. And we could also use the ballistic missile type for transmission of material from one part of the world. That is a practical thing as of today, is it not?

Dr. Stever. Well, it probably is not an economic thing because it is very difficult to have many materials that you will pay a lot for to transport that rapidly. That may not be true in the future.

Mr. McDonough. Thank you, Doctor.

Mr. O'Brien (presiding). Mr. Fulton.

Mr. Fulton. I have no questions but I would like to have the witness give his ideas on several statements for the record, if you will, please.

This committee needs advice on the programs for the Space Agency on the national space program. For example, first I would like to have your ideas on the surveillance and reconnaissance fields.

Second, on the policy that we should, as a Nation, follow on its security programs for the space age, and divide that security program in basic and applied sciences as well as the engineering fields.

Then I would like to have your ideas, too, on the governmental policy on patents, copyrights, trade secrets, and business property rights, including chemical formulas and mechanical procedures with regard to the space age.

Mr. Feldman. We will send the transcript to you so that will be all in the record.

Mr. Fulton. Then, because you are a young scientist who has made wonderful progress and is connected with a fine institution, MIT, I would like to have your ideas on how young people in this country can take part in these space programs. For example, all the young fellows and the teen-agers around our place, from 12 on, want to put some amateur rockets in the air, and they are not allowed to.

They are afraid they will get some on the roofs of some people and blow them apart.

Now, can we get a supervised national program going for rocket experiments for young people in grade and high schools as well as college levels?

Likewise, how would you recommend that we get a national program going for classes on space subjects in grade schools, high schools, and colleges to supplement current training?

Thank you very much.

Dr. STEVER. Thank you.

Mr. O'BRIEN. Mr. Feldman.

Mr. FELDMAN. Doctor, would you favor a strong provision in this law requiring a liaison with the military and a liaison with the Atomic Energy Commission?

Dr. STEVER. I do not know whether it is necessary to have it in the act. I do believe it is necessary to accomplish it, however, if the military and the nonmilitary programs in space are achieved efficiently.

Mr. FELDMAN. Such a provision is contained in the Atomic Energy Act and all the testimony we have indicates that it works very successfully. It is a directive, in other words.

Dr. STEVER. I do not think a directive is bad at all because it is an absolute necessity, I believe.

Mr. FELDMAN. Would you also favor having the head of this organization on a level equal to that of the Cabinet?

Dr. STEVER. Sir, I believe this is a growing activity.

I am perfectly confident we are not going to find this closing up because we cannot find more things to do in space technology.

I think it is going to be a mushrooming activity.

I would like to see the field established at this time to take account of a much more important role in the future activity of our Government. I feel it already has considerable importance, so I would answer the question affirmatively.

Mr. FELDMAN. I have no further questions.

Mr. FULTON. Is there room in outer space for politics?

Dr. STEVER. That is one of the questions I am going to stay away from. You must read Cicero on this.

Mr. FULTON. I have already written down to do it.

Mr. FELDMAN. I do have one more question, Doctor.

What would your reaction be to developing or providing for a central register of technical talent in this field?

Dr. STEVER. I would say that it might accomplish some things which are needed.

With respect to the leadership talent, it is already recognized. For example, you have a lot of them listed to testify to this committee. The leadership talent is recognized and I think if you take the sum knowledge of the military services, NACA, and so on, it is pretty well known which organizations have substantial technical talent. However, if there is to be, as a result of the formation of the new agency, a fair amount of shifting of talent from one group to the other, then it would be very valuable to have such a register.

Mr. FELDMAN. Would you also be in favor of including a provision calling for a joint congressional committee to which the agency would

respond such as we have in connection with the Atomic Energy Commission?

Dr. STEVER. On that question again, I cannot say that I am an expert but I do believe this: I believe very strongly that when matters of policy, major matters of policy, come up, we get a lot better result in the end if it has gone through our standard democratic procedures and is referred to the representatives of the people. In other words, I hope that something is set up by which the elected representatives of the people are in constant liaison, contact, with the space activity.

I hope we do not lose this contact.

Mr. FELDMAN. I have no further questions.

Mr. O'BRIEN. Any further questions?

Mr. SISK. Dr. Stever, I would like to have you make a statement in the record as to your position in regard to the security or the exchange of information on a worldwide basis or to what extent you feel classification of material may be necessary.

Mr. FULTON. I will join you on that question.

Mr. SISK. I will be interested in reading the record for your position on that.

Dr. STEVER. I certainly will do that.

(Material referred to follows:)

The data and other results of the scientific work which we do in space technology should be, by and large, given general circulation in the scientific journals of this country and throughout the world Of course, there will be some slight gain to our potential enemy from their having been given this data by us. But the amount of respect that we will get from the friendly peoples of the world, when they realize that we are primarily interested in space from a scientific and natural philosophy point of view, will more than outweigh these slight military advantages. Furthermore, our potential enemies will be forced into a poisition in which they will also reveal their accrual of data and knowledge.

It is certain that some of the rocket-vehicle techniques that we develop for our exploration of space, either by manned or instrument-carrying vehicles, will be of great use to the military in their applications of space technology. Clearly, we must be reasonable about keeping some matters which will give us a distinct military advantage secure from the potential enemy. I believe that the amount of information in this class will be limited.

The military security program in this country, with respect to technical data and knowhow, I believe, is overdone. In the first place, our security system is not very tight; most important leaks come, not from the activity of spies or traitors, but from the natural processes of democratic action in which agencies of Government, industry, and others release data in order to get support. I believe that many of the democratic processes of government could not be carried out as well if our security system were tighter. The security system that we do have tends to let loose the important facts and to keep the less important technical data secure not only from the enemy but also from some of our own scientists. I think it is overdone.

A security system soon develops other uses besides keeping important information from the enemy. It becomes a crutch on which we lean to cover up gaps in our own knowledge or to conceal some embarrassing facts. A person who is subject to a security system of this sort soon gets into the habit of classifying everything because it is so convenient to do so.

I believe we must carefully examine our space technology activity and select carefully the things which we must keep from the enemy and publish widely the rest

Mr. O'BRIEN. Doctor, the committee is very grateful to you. You have covered a wide range of subjects concisely and very well.

Dr. STEVER. Thank you, sir.

(Dr. Stever's prepared statement follows:)

STATEMENT BY DR. H. GUYFORD STEVER, ASSOCIATE DEAN OF ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, AND CHAIRMAN, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS SPECIAL COMMITTEE ON SPACE TECHNOLOGY

In laying the groundwork for our Government's major venture in astronautics and space exploration, as this Committee is helping to do, the most important consideration, I believe, is that this activity will be of long duration and of ever-growing importance. Man's interest in the physical universe outside his earth, and his desire to explore that universe, is very old and very intense. His capability to explore it physically and to send scientific apparatus well out into this universe is something which has been realized only in our generation. As this capability develops, I am sure his interest will grow even stronger. Because of all this, I believe we must plan an organization capable of giving us strength over many years, an organization capable of marked growth. I believe that we must not be overly influenced by the desire to do something spectacular on a short-term basis; we must lay a strong foundation both organizationally and technically.

The phases of astronautics and space exploration activities which have clearly yielded returns are the scientific and military phases. You are well aware of the rapid exploitation of these techniques in military technology, so I will not detail them. I am confident that this military exploitation should and will continue, and that from it not only will come increased military strength but also knowledge, techniques, and equipment which can be used for our nonmilitary space activity. Our nonmilitary organization and program, though not controlled by the military, should be in close contact with it for mutual exchange of ideas, data, techniques, equipment, and bases.

With respect to scientific research, both to learn more about the physical universe outside the confines of the earth, and to use this cosmic laboratory for a better understanding of the physical laws which govern physical processes here on the earth as well, these rocket techniques are unfolding a wealth of interesting possibilities. This scientific research, already well started, should grow apace.

What of the other nonmilitary aspects of astronautics and space exploration? Already, we see some simple engineering ventures of practical use involving communication relay stations and weather observation stations on satellites. Also, physical exploration of the solar system is something to begin in a limited way. There are some other long-term and highly imaginative accomplishments of space flight which are speculated upon by some. Personally, I believe that there will evolve many important uses of these techniques of space flight as we develop our capabilities in the field, though I am not one to attempt to predict these in detail at the present time.

Much has been made of the argument as to whether we should immediately start sending men into space either on satellites or on moon rockets. On manned space flight, it is my feeling that we still have a long way to go on two counts. In the first place, we will not be sure, until we have performed a substantial amount of experimentation, how difficult it is to put a man out there and return him safely. In the second place, we are not sure yet why we want a man to go. Certainly, much of our scientific experimentation and, in fact, some rather distant space exploration can be done without involving manned space flight. I do believe that there are enough possibilities in the long-term future both in military and nonmilitary ventures for a man to be needed in space flight that preliminary experimentation is justified Of course, the country that first puts man into space and returns him safely will make a deep impression on mankind and will gain great prestige. Personally, if I a choice is necessary, I would sacrifice early prestige for long-term strength in this field.

There are several kinds of activities which must be conducted simultaneously in order to develop our capabilities optimally. In scientific laboratories we must conduct research and develop equipment to perform the scientific experiments in space. In engineering laboratories we must work on the techniques and the technical fields which we must master before we can perform vastly more complicated flight into space. The flight work which we conduct must have at least two purposes: (1) To provide the vehicles for the transportation of scientific apparatus to whatever stations in space they must reach to perform the experiments; (2) to develop and test new vehicles and flight techniques.

In considering the organization and program to accomplish all this, you must first note where our capabilities lie. Personally, I am one who believes that

this country has very strong capabilities in this field and that our scientific, engineering, and industrial people will respond quickly to this challenge. There are several sources of this needed talent. In the first place, within the Government we have the National Advisory Committee for Aeronautics with its laboratories and flight stations, the Redstone Arsenal, and others, all of which have already conducted some important experimental work, particularly on flight techniques. There are other Government laboratories which have participated in the program of scientific experiment, the Naval Research Laboratory, the Air Force Geophysics Laboratory, and a number of others. There are a large number of university scientific laboratories which have been involved in the scientific experiments. Finally, we have strong industrial concerns, in which interests in this field primarily came about because of the military vehicles developments, but which have expanded their interests and strengths far beyond. The Government organization which is set up to handle astronautics and space exploration must use all of these strengths.

Without going into great detail about all the possible organizations proposed to do this job, let me say that, for several reasons, I favor the use of the NACA as a nucleus of a new organization to conduct our nonmilitary work in astronautics and space exploration. In the first place, the NACA laboratories have already done, and are continuing to do, a great deal of work in this field, particularly on the flight techniques. In the second place, NACA's relationship with the National Science Foundation and the National Academy of Sciences is such that they can use the important scientific research capabilities which these two organizations have. In the third place, NACA has longstanding close relationships with the military; there is a great overlap in the military and the nonmilitary uses of equipment for space exploration and experimentation. The new organization can use these well-founded relationships, first, to help the military solve its problem, and, second, to help itself by using military equipment.

It is important to consider this a new organization rather than an expanded NACA, for it must have a capability to contract with industry and academic institutions to perform sizable portions of this program. The NACA does not do this at the present time to the extent that will be necessary in this new activity.

Finally, there is one important point which is fundamental to this entire operation. It has to do with the decentralization of authority and responsibility, once the program is decided upon. In those stages in which we are now, essentially, discovering what our objectives are, what our organization should be, and what general program should be followed, I think it is important to tap all of the ideas from all sources. As we begin to carry out this program, we must continue to tap these ideas from capable organizations and individuals to find out what scientific experiments to perform, and to discover what techniques we should use to carry out scientific experiments into space. But, having decided upon an experiment or a program of experiments, I believe it is essential that responsibility and authority be delegated down to the working, technical level. A very complicated superstructure of detailed technical management within the Government, I believe, has seriously hampered some of our most important projects in space technology to date.

I believe that the leaders within the NACA understand this fundamental requirement for rapid progress in a technical venture.

Mr. O'Brien. The committee will be in adjournment until 10 o'clock tomorrow morning.

(Whereupon, at 5:30 p. m., the hearing was adjourned until 10 a. m., Tuesday, April 22, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

TUESDAY, APRIL 22, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION,
Washington, D. C.

The committee met, at 10:20 a. m., pursuant to recess, in the caucus room, Old House Office Building, Hon. John W. McCormack, chairman, presiding.

Present: Representatives McCormack, O'Brien, Metcalf, Natcher, Sisk, McDonough, Fulton, Keating, and Ford.

Present also: George J. Feldman, director and chief counsel.

STATEMENT OF DR. HUGH L. DRYDEN,[12] DIRECTOR, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

The CHAIRMAN. The committee will be in order.

The first witness will be Dr. Hugh L. Dryden, Director of the National Advisory Committee for Aeronautics.

We are very glad to have you appear before us, Doctor. Do you have a prepared statement?

Dr. DRYDEN. Thank you, Mr. Chairman. I have a prepared statement.

On April 2, the President transmitted to the Congress a special message recommending the establishment of a National Aeronautics and Space Agency.

On the same day, on direction of the President, the Director of the Bureau of the Budget transmitted to the Congress a draft of legislation to carry out this proposal.

In essence, the President's recommendation is for establishment of a new, independent Federal agency that will be responsible for programs concerned with problems of space technology, space science, and civil space exploration.

It is further proposed that the new agency, which I will refer to as the NASA, will use the present National Advisory Committee for Aeronautics, NACA, as its nucleus.

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[12] Dryden, Hugh Latimer, physicist; b. Pocomoke City, Md., July 2, 1898; s. Samuel Isaac and Nova Hill (Culver) D.; A. B., Johns Hopkins, 1916, A. M., 1918, Ph. D., 1919, Sc. D. (hon.), Polytechnic Inst. of Brooklyn, 1949, U. of Pa., 1951; D. Eng (hon.), New York U, 1950, Rensselaer Polytechnic Institute, 1951, married Mary Libbie Travers, Jan. 29, 1920; children—Hugh Latimer, Mary Ruth, Nancy Travers. With Nat. Bur. of Standards since 1918, as lab asst, 1918–19, Asso physicist, chief of aerodynamics sect., 1920–34, chief of mechanics and sound div. since 1934, prin. physicist, 1934–38, head physicist since 1938, asso. dir., 1946–47; dir. National Adv. Com. for Aeros., 1947—; U. S. del. adv. group aero. research and development, NATO. Mem. Nat. Investors Council, Dept. of Commerce, Wilbur Wright lecturer, Royal Aeronautical Soc, London, 1949. Hon. Officer, Civil Div. Order Brit Empire. Editor, Jour. of the Aeronautical Sciences. Hon. fellow Inst Aeronautical Sciences (pres 1943), fellow Royal Aeronautical Soc. (London); mem. Nat. Acad. of Sciences, Nat. Geographic Soc (life mem., board trustees), Am Soc. M. E., Am. Phys. Soc., Washington Acad. of Sciences, Philos Soc (Washington), Phi Beta Kappa, Sigma Xi. Wright Bros. lecturer, Inst. of Aeronautical Scis., 1938. Recipient, Reed Award, Inst. Aeronautical Scis, 1940; Medal of Freedom, 1946; Daniel Guggenheim medal, 1951. Methodist. Clubs: Cosmos. Author books; contbr. to tech. jours. Home 5606 Overlea Rd, Washington 16. Address: 1512 H. St N. W., Washington 25

In addition to its conduct of programs having to do with space technology, space science, and civil space exploration, the NASA will continue the aeronautical research programs of the NACA.

The President has instructed the NACA:

1. To present to the appropriate committees of the Congress a full explanation of the proposed legislation and its objectives.

2. To formulate such detailed plans as may be required to reorient the present programs, internal organization, and management structure of the NACA so as to carry out the functions of the NASA.

3. To plan programs necessary to implement the proposed legislation.

4. To review jointly with the Department of Defense pertinent programs currently underway within or planned by the Department of Defense, and to recommend to the President which of the programs should be placed under the direction of the new NASA.

5. To prepare jointly with the Department of Defense plans to assure that appropriate organizations, facilities, and other functions now within the Department of Defense be used in support of the NASA, either by cooperative arrangements or by transfer to the NASA.

6. To discuss with the National Science Foundation and the National Academy of Sciences, as well as with other governmental and nongovernmental bodies, participation by the scientific community on a continuing basis in the planning and coordination of scientific programs for the use of space vehicles.

My remarks are based on these instructions

I do not believe I overstate the case when I say that the need for the United States to assert its leadership in the fields of space is self-evident.

For the record, however, I should like to quote from the statement by the President's Science Advisory Committee, Introduction to Outer Space, dated March 26, 1958. Dr. Killian's group lists four factors that "give importance, urgency, and inevitability to the advancement of space technology," as follows·

> The first of these factors is the compelling urge of man to explore and to discover, the thrust of curiosity that leads men to try to go where no one has gone before. Most of the surface of the earth has now been explored, and men now turn to the exploration of outer space as their next objective.
>
> Second, there is the defense objective for the development of space technology. We wish to be sure that space is not used to endanger our security. If space is to be used for military purposes, we must be prepared to use space to defend ourselves.
>
> Third, there is the factor of national prestige. To be strong and bold in space technology will enhance the prestige of the United States among the peoples of the world and create added confidence in our scientific, technological, industrial, and military strength.
>
> Fourth, space technology affords new opportunities for scientific observation and experiment which will add to our knowledge and understanding of the earth, the solar system, and the universe

The draft legislation is explicit in declaring that our national space program shall be controlled by a civilian agency, except, and I quote—

> insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations

You gentlemen are familiar, I am sure, with the views of both the President and his science advisers that the nonmilitary implications

of space are so important as to require civilian, rather than military, control of the program.

I have the further thought, which I believe to be shared largely by the scientific community, that the extremely important, nonmilitary aspects of space might well become submerged, or perhaps, even lost, if included as an adjunct to a military program.

Recently, some doubt has been expressed that there will be widespread military application of the advances we make in space, except for reconnaissance and communication.

My own feeling on this point is that, today, we just don't know enough to predict with accuracy how much or how little of military value will accrue.

Instead of seeking in these beginning minutes of the space age to determine in great detail the full range of future military uses of space vehicles, we might better concentrate our efforts on the many, massive problems that require solution for us to explore our solar system.

On this point, I should like to be clear. We must enlarge and extend our effort to solve these large and difficult problems. I am confident that, as we make progress, there will unfold multiple uses for space flight, both civilian and military.

A half century ago, as Wilbur and Orville Wright were preparing to sell the first military airplane to the United States, a controversy had already begun that lasted many years. On the one hand were vigorous advocates of the airplane who reasoned that just as "he that commands the sea is at great liberty," so would he who gained control of the air control the world.

On the other side were those who argued that the crude, fragile airplanes of that day, underpowered by engines of dubious reliability, could hardly be expected to be of much military value.

Of course, the first airplanes were of very little use, but, over the years, research and development brought great improvements in the airplane, and we all know the profound changes that resulted.

Since 1915, when it was established by Congress, NACA has been charged with the responsibility to—

> supervise and direct the scientific study of the problems of flight, with a view to their practical solution * * * and to direct and conduct research and experiments in aeronautics.

Over the years, NACA has interpreted this to mean that its primary task was to provide the aircraft industry and the military services with information and technical data of a fundamental nature that would assist them in constantly improving military and civilian aircraft and missiles.

Since the end of World War II, NACA has been engaged increasingly in research applicable to the problems of space flight. It has designed and constructed special aerodynamic, propulsion, and structures research facilities required for this work.

At this point, Mr. Chairman, I should like to put into the record a chart showing the present organization of NACA and the effort being placed on space research.

I should also like to put in the record an unclassified version of a classified document describing some of this work in a little more detail.

The CHAIRMAN. Without objection, it is so ordered.

Dr. DRYDEN. Thank you, sir.

(The material referred to follows:)

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

NACA RESEARCH INTO SPACE

INTRODUCTION

In this technological age the country that advances most rapidly in science will have the greatest influence on the emotions and imagination of man, will have the greatest rate of industrial and economic development, the highest standard of living, and the greatest military potential, and will command the respect of the world. The scientific advances of the Soviets in their bid for world supremacy have been amply demonstrated by the recent success of their satellite program. These advances are the results of a far-reaching plan and sustained effort that poses a most serious challenge to the United States and the Western World. It is of great urgency and importance to our country both from consideration of our prestige as a nation as well as military necessity that this challenge be met by an energetic program of research and development for the conquest of space.

This task requires rapid extension of knowledge into regions already familiar and penetration into still unexplored areas. Urgency dictates the maximum effective utilization of existing facilities, knowledge, and organizations. The NACA is an organization in being, already engaged in research applicable to the problems of space flight and having a great many of the special aerodynamic, propulsion, and structures facilities required, and qualified to take prompt advantage of the technical training and interest of scientists competent to help in the research on space technology. During the past half century this country achieved and later exploited world leadership in solving the problems of flight. The NACA, in partnership with the military services, other branches of the Government, the scientific community, and industry has played a leading role in this achievement.

The NACA in 1952 formally initiated studies "of the problems associated with unmanned and manned flight at altitudes from 50 miles up, and at speeds from Mach 10 to the velocity of escape from the earth's gravity." Since that date, the NACA's major aeronautical research centers and field stations have concentrated increasingly upon solution of problems of ballistic missiles, hypersonic aircraft, and space vehicles.

The objective of this document is to present briefly information about current NACA research having application to missiles and space flight.

NACA's part of the critical challenge now facing the Nation can be met with an expanded NACA program and with the support of the Congress for the needed additional manpower and research equipment.

MISSION OF THE NACA

The National Advisory Committee for Aeronautics was established as an independent Government agency reporting to the President by act of Congress of March 3, 1915, and authorized to "supervise and direct the scientific study of the problems of flight, with a view to their practical solution * * * and to direct and conduct research and experiment in aeronautics" (50 U. S. C. 151).

During the past 42 years, the National Advisory Committee for Aeronautics has sought to assess the current stage of development of aircraft to anticipate the research needs in connection with the problems of flight; to build the scientific staff and unique research facilities required for these research needs; and to acquire the new knowledge as rapidly as the national interest requires.

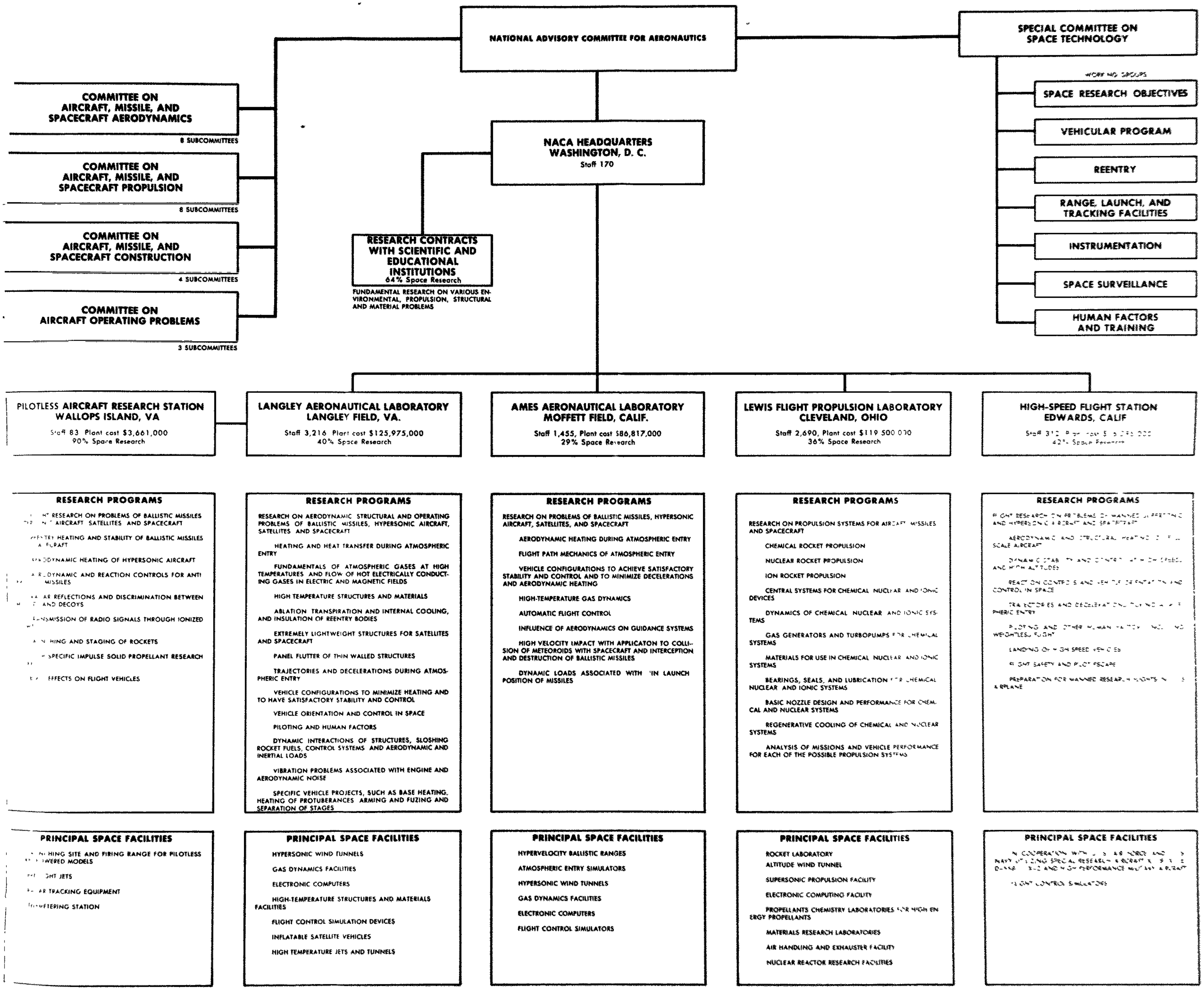
By discharging its primary responsibility—scientific research—NACA serves the needs of all departments of the Government.

The 17 unpaid members of the NACA are apopinted by the President and report directly to him. They establish policy and plan the research to be conducted by the 8,000 scientists, engineers, and supporting personnel who comprise the staff of the Agency.

The membership of the NACA and its broadly based technical subcommittees, including NACA's Special Committee on Space Technology, includes personnel from both military and civilian agencies of the Government and representative scientific and engineering members from private life, thus assuring full coopera-

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

ORGANIZATION AND DISTRIBUTION OF EFFORT RELATED TO SPACE RESEARCH FOR THE FISCAL YEAR 1958



tion with the military services, the scientific community, and industry. NACA's organization has proved to be an effective national research and coordinating body.

The NACA's research programs have both the all-inclusive, long-range objective of acquiring new scientific knowledge essential to assure United States leadership in solving the problems of flight and the immediate goal of solving, as quickly as possible, the most pressing problems.

The scientific research is conducted at NACA's major research centers: Langley Aeronautical Laboratory, Virginia; Ames Aeronautical Laboratory, California; and Lewis Flight Propulsion Laboratory, Ohio. Flight research is also conducted at the high speed flight station, California; and the pilotless aircraft research station, Virginia.

AERODYNAMICS AND SPACE MECHANICS

In recent years the research of the NACA has been directed increasingly to the problems of aerodynamics at the hypersonic speeds required for flight beyond the atmosphere. The objectives of this research include:

1. More fundamental understanding of airflow characteristics and high-temperature conditions occurring at hypersonic speeds as during reentry to the earth's atmosphere, including the physical and chemical changes in the air and the effects of these changes on the flow.
2. Information about the heat transfer and forces applied to ballistic missiles and hypersonic and space vehicles.
3. Information about stability, control and guidance requirements, and means for satisfying these requirements for flight both within and outside the atmosphere.
4. Evolution of missile and space vehicle configurations of various kinds, compatible with propulsive and structural requirements, and capable of performing useful scientific or military missions under all the conditions of environment and speed imposed by the desired flight plans.

NACA research in this area has included work on the problems of both missiles and manned aircraft. With respect to the difficult ballistic missile reentry problem, the NACA contributed in 1952 the concept of the high-drag, blunt warhead to minimize aerodynamic heating. All current ICBM and IRBM warheads employ this concept. Successful reentry has been achieved with an intermediate range ballistic missile nose cone designed according to this principle. Work is now being directed toward advanced nose cones which have higher impact speeds. This will permit design of ballistic missiles that will achieve improved target accuracy and be more difficult to intercept.

In addition to ballistic missiles, the NACA has concerned itself with problems peculiar to antiballistic missiles. The studies include the aerodynamic requirements of antiballistic missiles to permit them to perform their mission without undue electronic complexity. Effort is also being exerted to obtain configurations having desirable characteristics of speed and maneuverability and to solve the very difficult problem of control to achieve interception in the upper reaches of the atmosphere.

Interest in manned flight at hypersonic speeds and in space led the NACA to make the proposal which resulted in the cooperative NACA-USAF-USN project, the X–15 research airplane designed and now under construction for studying some of the problems of manned flight in nearby space. This airplane is designed to reach altitudes where the aerodynamic forces will be negligible to permit study of problems of flight mechanics and reentry into the atmosphere of a piloted vehicle. This proposal was made 2 years before the X–2 research airplane exceeded a speed of 3 times the speed of sound and reached an altitude in excess of 25 miles. Space controls in the form of small rockets are provided as well as aerodynamic controls. Space controls have been installed in an older research airplane which is now being flown to study the problem of merging space controls at high altitudes with aerodynamic controls at lower altitudes.

One important aspect of this program has been concerned with man's ability to operate the vehicle and its dynamic behavior, both within and beyond the atmosphere. Laboratory simulator studies using research pilots have identified conditions of dangerous divergent motions during exit and reentry, and provided information on stabilization and control requirements.

For more than a year the NACA has been making an intensive study of the feasibility of a research hypersonic glider with an airframe capable of flight at

all speeds up to satellite velocity. Such a vehicle would be capable of exploring the problems of manned space flight and reentry at extreme speeds including aerodynamic heating, orientation, navigation, aeromedicine, and electronics. The vehicle envisioned would be capable of extensive gliding within the upper atmosphere and of landing in a normal manner at a large airbase. Exploratory studies are also underway on alternate approaches to the operation and recovery of manned satellites These alternates would employ a lighter vehicle which, however, may be less flexible in operation. Although many problems remain to be solved, no insuperable difficulties have been discovered. These studies are now serving, in no small measure, to channel into proper direction research on the increasingly urgent problems of space flight.

Many types of existing NACA laboratory facilities are being used to contribute to the solution of ballistic missile, hypersonic aircraft, and spacecraft problems in aerodynamics. Even subsonic and transonic wind tunnels, as well as high-speed equipment, are being used effectively in studies of such problems as dynamic stability, fusing of warheads during reentry, the magnitude of hinge moments on gimbaled rockets used for control during powered flight, and landing characteristics of hypersonic aircraft.

Supersonic and hypersonic wind tunnels, hot jets, and hypersonic ballistic ranges are being used to study many problems, especially those involving boundary-layer effects and heat transfer.

Small tunnels using air provide speeds up to a Mach number of about 10, and larger equipment is now under construction. Helium has been used in small wind tunnels to simulate Mach numbers up to 20, and procurement of larger equipment for this purpose is now underway. A large new wind tunnel will provide a hypersonic airstream from a pebble-bed heater with temperatures in the 2,500° to 3,000° F. range. Smaller equipment already in use employs pebble-bed heaters at temperatures to about 4,000° F. Combustion heated jets cover an even larger range of temperatures.

The wind tunnel cannot, however, provide complete temperature simulation in air at the higher hypersonic speeds because of material limitations. The NACA is placing much effort on the development of other types of high-temperature apparatus to study the physical and chemical changes in air at hypersonic speeds Small air jets from electric arcs are providing temperatures up to about 15,000° F., but further technique development is required. Shock tubes are also being used to provide high temperatures, but their usefulness is currently limited by very short durations and by the low Mach numbers of the flow. Developments are now underway to obtain high-temperature hypersonic airflows with useful flow durations

One of the most valuable research tools is the hypersonic ballistic range which provides simulation of both speed and temperature effects in air. Guns and methods of using them to propel models of useful shape and size already have been developed to reach Mach numbers of about 15. Equipment now under construction will increase substantially this speed. In one variation of the ballistic range, the model is shot upstream into a special supersonic wind tunnel to obtain higher speeds than are obtainable by gun launching into still air.

A small atmospheric reentry simulator is also being used, in which the model of a ballistic missile nose cone is shot upstream in a special nozzle of a supersonic wind tunnel. A large reentry simulator, now under construction, will provide conditions equivalent to those experienced by large, long-range ballistic missiles and satellites.

Although every effort is being made to improve our ability to simulate the actual conditions of speed, scale, and temperature in laboratory facilities, complete simulation of all conditions simultaneously is possible only in flight. The pilotless aircraft research station at Wallops Island, Va., established 12 years ago to obtain aerodynamic data at transonic and low supersonic speeds, is now being used almost exclusively on hypersonic and space flight problems. Data are currently being obtained, for example, from models of ballistic missiles and spacecraft accelerated downward from the top of their trajectories to Mach numbers as high as 16. The models are propelled by multiple staging of solid-propellent rockets. This low-cost system has demonstrated simplicity and reliability of operation. Work is underway to increase the speed of simple research rockets to satellite and perhaps escape velocities in the not-too-distant future. The ground range facilities and highly developed, specialized telemetering instrumentation available permit the measurements needed for a wide variety of aerodynamic, structural and material investigations.

Recent NACA rocket-flight research has made contributions to the knowledge of transition from laminar to turbulent boundary-layer flow which is important to heat transfer to both ballistic missiles and hypersonic winged vehicles. In addition to such research, a number of rocket-powered model flights have been made to obtain specific information about the ICBM and IRBM warhead shapes now being developed for the military services.

PROPULSION

Powerplants for spacecraft must accomplish three objectives (1) Provide sufficient velocity to overcome the earth's gravitational field; (2) provide sufficient velocity control, both in magnitude and direction, to permit the desired flight path in space, and (3) provide such auxiliary power as is required. NACA propulsion research is being directed to the accomplishment of these objectives.

To meet the first objective, the thrust must exceed the gross weight by a sufficient amount so that the energy consumed in overcoming gravitational force is not an excessive fraction of the total energy available On the other hand, the thrust-to-weight ratio should not be so high that final accelerations exceed allowable limits.

In order to meet the second objective, velocity and directional control must be available throughout the entire mission, which may be measured in terms of days or months. Hence the rate at which the propellent is consumed becomes at least as important as the thrust-to-weight ratio; powerplants such as the ion rocket having thrust-to-weight ratios in the range from one-thousandth to one ten-thousandth become of interest since their propellent consumption rate is very low.

For auxiliary power, the weight per unit of power output must be as low as possible. The weight of the energy source carried is also important, but in many missions the possibility exists of using an exterior energy source, such as the sun. The choice between external and internal energy sources will depend on the duration of the mission, the total energy requirement, and the relative weights of each source and its associated equipment.

To satisfy the above requirements, NACA studies are being made of the (1) energy sources available—chemical, nuclear, solar; (2) the working fluids to be used—combustion products, lightweight gases, ions, plasma, photons; (3) possible heat transfer fluids—gases or liquids; (4) the mechanical devices by which the energy is converted into thrust or power—nuclear or chemical rockets, ion, plasma, or photon jets; (5) the particular steps traversed from energy source to thrust or power—nuclear or chemical energy to heat or to electricity, and thence to acceleration of the working fluid; (6) the methods of controlling the powerplant, and (7) the materials of which the powerplant is made and the environment in which they operate.

Current NACA rocket research is concerned primarily with rocket engines of high performance for space and ballistic missions. Investigations involve a variety of theoretical and experimental work. The theory includes the study of rocket cycle thermodynamics, flight dynamics, and the calculation (by use of digital computers) of the combustion gas temperature and composition under a variety of conditions, and the vehicle performance that may be realized. Experiment includes studies of the basic injection processes of propellent mixing and atomization; relative reactivity of fuel-oxidant combinations, ignition and starting transients, combustion instability, and heat-transfer processes. There are in addition studies involving liquefied gases. This research is concerned with suitable means for pumping, piping, and control systems for liquefied gases as propellents. Methods of cooling of rocket engines with the liquefied propellent gases are also under study.

Specific NACA research projects have been completed on fundamentals of ignition at altitude and low temperature with self-igniting propellents; solutions to the ignition problem in the form of fuels for use with the storable liquid oxidizer (nitric acid); performance parameters of propulsion systems, basic studies of combustion instability to clarify the mechanism and to control it, and the selection of propellents for research for high performance missions. In the research propellents on high impulse, emphasis has been on hydrogen and hydrazine with either oxygen or fluorine as an oxidant. The heat transfer characteristics of high-energy liquid propellents are under study. Fluids being studied are hydrogen, fluorine, oxygen, nitrogen, ammonia, and water.

Since 1950, the NACA has studied the application of nuclear energy to aircraft and rocket propulsion systems. This work includes cycle analysis, heat

transfer, shielding, materials, and reactor physics. Of particular interest to nuclear rockets for space propulsion is a current program to determine the compatibility of uranium compounds with various high-melting structural materials at temperatures of 5,000° F. and above. This work supplements, and is being done in coordination with, the work of the AEC Los Alamos Laboratory. A 60-megawatt research reactor is being constructed near Sandusky, Ohio, to further research on the effects of heat and nuclear radiation on powerplant materials and components. This facility will permit investigation of complete heat transfer loops for the primary propulsion and auxiliary power systems required in controlling or sustaining space flight.

As a guide for experimental studies and to place the numerous possible powerplant systems in their proper perspective, extensive analytical studies have been made comparing the relative merits and areas of application of nuclear- and chemical-fueled vehicles. Results of these studies were presented to industry and the armed services in our 1957 flight propulsion conference.

In the chemical rocket the working fluid and the energy source are the same. Since this is not true in the nuclear rocket, the ion jet or the plasma jet, and therefore a choice may be made from a wide range of fluids, research on the characteristics of the fluids suitable for use in these devices is being conducted. Effort is being directed toward obtaining a low ratio of power required for thrust produced. Launching a spacecraft requires research on the complete rocket propulsion system from the liquid propellent tanks to the exist of the exhaust nozzle. The NACA is conducting research on the turbomachinery required to transfer the propellent from the propellent tanks to the combustion chamber, on the propellent injection system which is a major factor in determining combustion efficiency and stability, on the combustion process and on the effect of discharge nozzle design.

The 15 years of NACA research on turbomachinery for the turbo-jet engine provides a background of research data and personnel directly applicable to rocket turbine and pump systems for IRBM, ICBM, and spaceflight. The need for high pumping power and lightweight require the use of high-speed turbines and pumps. The corrosive nature of some of the oxidants requires special attention to materials, lubricants and seals; a research program to supply solutions to the materials, lubricants, and seals problems with corrosive oxidants is being vigorously pursued.

As solid propellent specific impulses are increased to the point where they can be used for spacecraft, research will be required on methods for controlling thrust time history and the interrelation of this and the guidance system. The exit nozzle research and much of the combustion research already discussed is applicable to solid as well as liquid propellent ballistic and space vehicles. As facilities become available, research in the solid propellent field is being expanded.

Existing facilities have been used to make investigations of critical problems associated with the design of the Thor and Jupiter missiles.

Work applicable to powerplants to provide the energy for ion jets or plasma jets has begun. For the most part this work is in the analytical stage. Emphasis from the weight standpoint is on the power producing unit rather than the propellent accelerating unit. The analyses being conducted on these systems indicate the need for research on higher temperature and more efficient power generators. Solar energy is being studied but currently only in the analytical field.

The control precision required by spacecraft, including IRBM's or ICBM's, necessitates more precise control of fluid flows, and of mechanical equipment operation than has been required previously for flight within the atmosphere. The controls research conducted at the Lewis Laboratory is being channeled into the spacecraft requirements.

Spacecraft powerplants demand a high order of operational reliability for times varying from a few minutes to many days. To achieve such reliability places severe demands on materials and the ingenuity of their application. This is particularly true in view of the very high working fluid temperatures required. The NACA materials research for chemical and nuclear rockets has two objectives: (1) To obtain the maximum temperature possible either by improving material physical properties or through cooling, and (2) to improve the operational life and reliability. Structural material requirements for ion and plasma jets are still not well defined. Emphasis on the materials studies is being given to molybdenum and tungsten metal groups and to ceramics.

STRUCTURES AND MATERIALS

Successful operation of long-range ballistic missiles and manned spacecraft depends in no small way upon structural ability to cope with the very large range of aerodynamic and thermodynamic loads and stresses experienced. The same structure that withstands the extremely large thermal and erodynamic loads and stresses generated during exit from and reentry into the atmosphere must also be strong during flight outside the atmosphere where temperatures are very low and there is always present the danger of hypervelocity impact with meteoric dust and larger meteoroids.

The increasingly large part of NACA research on structures and materials applicable to the design of missiles and spacecraft must of course consider load and stress conditions imposed throughout the entire flight mission. Remembering that minimizing weight is the overall goal of structures and materials research, some of the more specific objectives of this research include:

1. Establishment of the interactions of heat, aerodynamic force, structural elasticity, and inertia, thus to aboid destructive vibration phenomena.
2. Evaluation of structural configurations for various temperature ranges, including for the highest temperatures, composite arrangements that incorporate cooling, insulation, and heat shields.
3. Determination of properties and behavior of structures at high temperatures and under transient heating.
4. Evaluation of the heat-resistant capabilities of existing materials and their applicability to space structures, ballistic missiles, and hypersonic aircraft.
5. Development of new materials with improved high-temperature properties such as are required for reentry into the atmosphere at hypersonic speeds.

To determine the complete behavior of missile and aircraft structures at high temperature it is necessary to perform the tests in an airstream of suitable speed. As early as 1952, use of the NACA's first supersonic true-temperature wind tunnel made possible isolation and study of a previously unknown form of destructive flutter caused by thermal stresses brought on by transient heat flow. The data from this facility made possible, in advance of production, structural changes in the design of several missiles and supersonic airplanes then being developed.

Recently a major supersonic facility known as the 9- by 6-foot thermal structures tunnel has been completed and put into operation. It permits study of much larger structural specimens under conditions of high heating rates and at temperatures to 700° F. A more advanced version of this type of facility is now being designed to permit testing of equally large specimens to 4,000° F. and at hypersonic speed.

Missile structures which are subjected to constantly changing loads and temperatures in their flight through the atmosphere have also been improved in NACA's laboratories by studying them under timed programs of load and temperature that simulate their flight.

Important examples of recent structural studies relating to hypersonic flight are those for the X-15 and the projected research hypersonic glider capable of satellite speeds. Although the X-15 is to be used in study of the severe heating problems experienced at high speeds it was found possible to use relatively conventional structures. Original studies included tests of various box beam configurations with both load and heat input programed in accordance with anticipated flight conditions. Buckling stresses, ultimate strength, and deflection characteristics were determined. Vibration tests also have been made to determine modes and frequencies of the hot structure, and the loss of stiffness resulting from heat.

Theoretical and experimental studies have been made of various types of sandwich panel configuration suitable for the structure of a hypersonic glider. These investigations include panel flutter tests under heated conditions, and studies of the relative efficiencies of bare structures of refractory materials and structures with heat-shield, insulation, and cooling systems.

Research on materials is centered largely on their properties and behavior under the conditions of reentry in space flight. Mechanical properties of many alloys have been obtained under conditions of transient heating. Total heat capacities have been determined for a variety of metallic and nonmetallic materials. Various protective coatings for refractory metals and other materials have been tested. Means have been provided for coating metals with high emissivity materials that remain stable at high temperatures. Relative ablation rates have been established for many materials under high-temperature

conditions. Impact studies have been made with various combinations of materials over a wide range of Mach numbers. Fundamental information regarding penetration and cavitation volume under impact also has been obtained.

The severity of the reentry problem and the demand for materials with high temperature capabilities have led to attempts to improve existing materials and to develop new ones. In this area the causes of brittleness in ceramic materials are being investigated with the hope that development of ductile ceramics may be possible.

Hot air jets employing ceramic heat exchangers that operate at 4,000° F. are currently playing an important role in this study of materials for ballistic missile nose cones and spacecraft reentry vehicles. One of these jets will soon be extended to have a 5,000° F. hypersonic airstream 12 inches in diameter.

The NACA has also developed air jets heated by high intensity a. c. electric arcs. Currently in operation is an apparatus that produces a M–2 air jet of ½-inch diameter and temperature of 12,000° F. Under design is a similar facility that will permit testing of 6-inch diameter models to temperatures above 20,000° F. with heating rates to 10,000 Btu/sq ft./sec and under correct conditions of Mach number and air density for the reentry problem.

Other hot jets employing ethylene or rocket fuels to produce temperatures from 3,500° F. to 8,000° F. are being used for studies of melting and ablation, and for quick comparisons of materials for which oxidation is not a factor.

Such equipment as the ballistic ranges and atmospheric reentry simulator mentioned previously, while designed primarily for aerodynamic study, are also used for study of some materials problems. This has been true especially in the case where the high velocity impact of meteoroids has been simulated. Data also are being obtained on materials and structural properties using NACA-developed hypersonic rocket techniques.

Although high temperature predominates as the newest and most difficult environmental factor affecting the structure and its material, many problems at ordinary temperatures remain. Moreover, insight into the complicated high-temperature problem is provided by the background of research performed by the NACA over a period of many years. Results of research on strength, buckling, stiffness, efficiency, and vibration modes of many structural configurations of wings, cylinders, tapered bodies, et cetera, have found their way into missile hardware.

Important flutter and vibration problems also continue to be studied at ordinary temperatures. The cylindrical structures of large rocket boosters are thin-skinned and subject to panel flutter, fuel sloshing loads, and acoustic excitation. Studies of these dynamic phenomena also include the effects of coupling of the vehicle control system with its structural dynamics.

Dr. DRYDEN. We have made available to the committee the classified version, which includes some aspects which cannot be put into the open record.

I would be remiss if I did not note that this essential development of new research techniques and new research tools by the NACA would have been impossible except for the support Congress has given. The facilities at the NACA research centers and field stations have cost more than $350 million, every dollar of which has been appropriated by the Congress. Some 20 years ago, the respected British Journal, Aircraft Engineering commented editorially on the NACA practice of pioneering in its research programs, as follows:

> The present-day American position in all branches of aeronautical knowledge can, without doubt, be attributed mainly to this far-seeing policy and expenditure on up-to-date laboratory equipment.

The same statement, I believe, could be made with equal validity respecting today's work of NACA to acquire new knowledge about aerodynamics, materials, structures, and propulsion.

A second important role of NACA since 1915 has been coordinating aeronautical research in the United States. Through the members of the main committee and its 28 technical subcommittees, the NACA has linked the military and civil Government agencies concerned with

flight. The aviation industry, allied industries, and scientific institutions have also been represented. Today, nearly 500 men are serving on these committees. They are chosen because of their technical ability, experience, and recognized leadership in a special field of competence. They are acting in a personal and professional capacity as they give of their time and talent, without compensation. They furnish assistance of great value in considering problems related to their technological fields. They review research in progress at NACA laboratories and in other establishments, they recommend new research to be undertaken, and they assist materially in the coordination of research programs.

Our committee structure has not been a mechanism for obtaining group approval of the recommendations and actions of NACA's professional staff. Rather, it has proved to be an extremely helpful device, with the committees serving as forums in specific technical areas. Informed and free discussion at these meetings has produced much useful material to help the staff in programing its research effort.

By way of illustration, I should like to tell you about one of these technical groups, the NACA's committee on aerodynamics. At its regular meeting, January 30, 1952, the 22 members of the committee considered a special presentation by a fellow member, the late Robert J. Woods of Bell Aircraft Corp. Its title was "Establishment of a Study Group on Space Flight and Associated Problems." Mr. Woods called for basic research on, and I quote, "the mechanics and problems of space flight." Mr. Woods suggested that NACA was the logical organization to carry on the basic studies in space flight control and stability as it is a logical extension of work now being done by the NACA, and urged that NACA establish a concept of a suitable manned test vehicle and that as soon thereafter as possible, such an airplane be built.

These proposals, I remind you, were made nearly a year before man first flew at twice the speed of sound. Incidentally, that man was an NACA research pilot. These recommendations made in January 1952, for manned exploration into nearby space at speeds more than 6 times the speed of sound (3,960 miles per hour) have resulted in the cooperative X–15 research airplane program in which NACA has the responsibility for technical direction and in which the Air Force, the Navy, and the aircraft industry are participating.

The sequence of events leading to the awarding of contracts late in 1955 to North American Aviation, Inc., and Reaction Motors, Inc., for construction of the airframe and powerplant, respectively, was as follows: After consideration by the main committee, the NACA staff began studies of the "problems associated with unmanned and manned flight at altitudes from 50 miles up and at speeds from Mach No. 10 (about 6,600 miles per hour) to the velocity of escape from the earth's gravity (25,000 miles per hour).

Intensive programs were conducted at the NACA research centers to provide technical information that was essential in the undertaking of such a project. About this time, NACA's Ames Aeronautical Laboratory solved the atmosphere reentry problem for ballistic missiles. Further NACA research provided information vital in the shaping of wings and control surfaces. These contributions were directly applicable to the X–15 program. In this work, special re-

search facilities, made available by the congressional appropriations in previous years, proved of great value.

By 1954, NACA had sufficient information to present to the Air Force and Navy a detailed proposal for design and construction of an aircraft capable of the extremely high speeds and altitudes necessary for exploration into nearby space. A memorandum of understanding, establishing the procedures to be followed in acquiring and using the rocket plane, was signed by the Air Force, Navy, and NACA. Thereafter, manufacturers were invited to submit their proposals. This airplane will make its first flights next year.

The X–15 will incorporate many design innovations. One example is its control system. Because the airplane will fly to heights where the air is extremely thin, aerodynamic controls will be ineffective. Consequently, it was necessary to devise new controls that work on the jet-reaction principle. For the past year, NACA pilots have been flying a research airplane fitted with this new kind of space control system.

Even as the work is pushed to complete the X–15 and begin man's first exploration of nearby space, steps similar to those I have outlined are being taken on projects that will be needed to enable man's venturing still farther into the unknown.

I have discussed in detail the committee mechanism employed so successfully by NACA because it is a device that will be equally useful in the new fields of space. Last fall, NACA Chairman James H. Doolittle appointed a special committee on space technology. Time was required to permit the top-ranking people chosen for this task to rearrange their workloads in order to serve. Several meetings have been held and working groups are now busy on specific problems.

This committee is headed by Dr. H. Guyford Stever, associate dean of engineering at Massachusetts Institute of Technology. He formerly was chief scientist of the Air Force. The committee includes H. Julian Allen, NACA Ames Aeronautical Laboratory; Col. Norman C. Appold, United States Air Force; Dr. Hendrik W. Bode, director of mathematical research, Bell Telephone Laboratories; Dr. Milton U. Clauser, director of aeronautical laboratory, Ramo-Wooldridge Corp.; Prof. Dale R. Corson, Cornell University; James R. Dempsey, manager, astronautics division of Convair; Robert R. Gilruth, NACA Langley Aeronautical Laboratory; S. D. Hoffman, general manager, Rocketdyne division of North American Aviation, Inc.; Abraham Hyatt, Navy Department; Dr. W. Randolph Lovelace II, Lovelace Foundation for Medical Education and Research; Dr. William H. Pickering, director, jet propulsion laboratory, California Institute of Technology; Dr. Louis N. Ridenour, Jr., missile systems division of Lockheed Aircraft Corp.; Abe Silverstein, NACA Lewis Flight Propulsion Laboratory; Dr. James A. Van Allen, department of physics, State University of Iowa; and Dr. Wernher von Braun, Director, Operations Division, Army Ballistic Missile Agency.

For NACA to become the nucleus of the NASA and to accomplish promptly and effectively the heavy responsibilities that are outlined in the legislative draft submitted at the direction of the President, considerable reorientation of present research programs will be necessary. As a matter of fact, NACA has been reorienting its research effort for several years. We have, for example, shifted much of our powerplant emphasis from air-breathing engines, which are now

reaching an advanced state of development, to rocket engine types. These latter can be used not only to propel ICBM's and satellites, but to send, first unmanned and then manned, spacecraft to the moon and beyond. Similarly, the work we are doing on structures and structural materials is now being focused on problems peculiar to missiles and vehicles that travel beyond the earth's atmosphere. At the same time, these structures have to be suitable also for flight within the earth's atmosphere at the beginning and final stages of any journey. Also, they have to be able to withstand the extremely high temperatures generated by aerodynamic heating. Useful research on this latter problem already has been accomplished; more remains to be done. Fortunately, new NACA research tools, design, and construction of which has been made possible because of appropriations in recent years by the Congress, are now becoming available.

The President's recommendations call for the proposed NASA to study the problems of flight "within or outside the earth's atmosphere with a view to their practical solution." Very few people in aviation believe that the potential of the airplane has been fully attained for either military or commercial purposes. Further, it appears that, as in the past, the key to continued progress in aviation is research, intelligently planned and vigorously prosecuted. Fortunately, many of the problems affecting the launching and recovery of space vehicles are the same as those demanding solution if our airplanes are to reach their desired performance potentials. In my considered judgment, it would be a grave error to attempt separation of the research programs needed for aeronautics from those of space technology.

We are making plans with regard to our internal organization and the management structure of the NACA, to assure that the expanded operations, especially in the areas of space vehicle development and use, be promptly and efficiently undertaken. Although these plans have not been finalized, they will include new elements as well as the effective operating mechanisms evolved by NACA over the past 43 years.

In particular, you will note in the bill provision is made for contract operations on a much wider scale than has been used by NACA in the past.

We are also planning additional actions and programs that will be necessary to assure rapid implementation of the proposed legislation. This planning includes determination of the requirements for additional staff, facilities, and funds that will be needed. In connection with the draft legislation transmitted to the Congress on April 2, 1958, the Director of the Bureau of the Budget submitted a preliminary, minimal estimate that the expenditure of NASA, over and beyond the current $100 million budget of NACA, would range from $100 million in fiscal year 1959 to $300 million in the fiscal year 1962. Those are expenditures and not appropriations. In the near future, we will submit detailed requests for appropriations in support of proposed programs.

We have undertaken, with officials of the Department of Defense, the review requested by the President of pertinent space programs currently underway or planned by the Department of Defense. These include the several programs announced March 27 at the White House, which will permit unmanned exploration of space in the vicinity of the moon. The programs might have been called lunar probes.

I might say at this point that we are determined to take no action which will delay or interrupt the programs which have been approved.

I, for one, might be concerned about the difficulties that could be expected to occur in the process of determining what current and planned Department of Defense space programs should be placed under the direction of the NASA were it not for the fact that for the past 43 years the military services and NACA have worked together, cooperatively, and what is more important, effectively. Just because we will be venturing into unknown areas of interplanetary space is no reason why this happy, essential partnership arrangement needs to change.

I should like now to consider the relationship of NASA with other agencies. As we learn to fly farther into space, carrying man some day on exploration flights to the planets, the idea of exploiting the great potential of nuclear energy becomes more attractive and perhaps even essential. Since the war, NACA has worked closely with the Atomic Energy Commission in studying problems of aircraft and rocket engines using nuclear energy. AEC effort has been concentrated upon problems peculiar to nuclear powerplants. NACA's effort, in turn, has been focused on problems of how to exploit the potentialities of such engines, incorporating them in aircraft and missiles. There has been close coordination of this continuing work. AEC personnel have served on NACA committees; NACA technical people have worked similarly with AEC groups. The future relationship, between AEC and the NASA, can be expected to be even more intimate, but I foresee no fundamental change.

In the past, the NACA has concentrated for the most part on flight problems in the fields of aerodynamics, propulsion, and structures and structural materials. These are the areas where NACA has the greatest competence and the best research tools. Flight into space requires that great effort also be devoted to such problems as electronics, guidance, and physiology or human factors. We plan to make substantial use, by contract, or organizations with competence already demonstrated in these related fields of technology.

As indicated earlier, a most important part of our national space program must be the effective use of space vehicles to collect information of value to the scientific community.

It is imperative that the best scientific judgment available be employed to determine space science objectives, and to this end it will be necessary that the NASA work most closely with the National Science Foundation and the National Academy of Sciences.

Parenthetically, I would refer to the paper dated February 14, 1958, by the Technical Panel of the Earth Satellite Program of the United States National Committee for the National Geophysical Year, National Academy of Sciences, which is entitled "Basic Objectives of a Continuing Program of Scientific Research in Outer Space." I believe this has been published in a congressional document. To both the scientist and the layman, this is a fascinating outline of the new knowledge that can be acquired through the effective use of our newest of research tools, the space vehicles.

Finally, I wish to discuss in a general way some aspects of the space programs we will be proposing soon for NASA accomplishment. First, there must be adequate research effort on space technology problems. Then there must be development and use of unmanned

vehicles capable of carrying the necessary scientific data-gathering apparatus. Finally, there must be development and orderly use of man-carrying vehicles in the exploration of our solar system.

I think I should note that these programs won't be planned for accomplishment in sequence, although I would expect, for example that the journeys of man-carrying space craft to Mars or Venus certainly will come much later than some of the other work. Rather, what I envision for NASA will be essentially a three-part, comprehensive program, with progress being made in all three areas, as rapidly as the new knowledge is acquired.

One of the projects we would like to begin as quickly as possible would be development of a satellite capable of carrying, in orbit, an astronomical telescope and the auxiliary television equipment necessary to send to earth the pictures taken through the scope. To be able to observe the stars and the galaxies from a point in space where there would be none of the distortions caused by our atmosphere would enable astronomers to gather a wealth of new information about our universe.

As the more oratorically inclined scientist put it, the earth is a blanket that cuts off part of our view. It is like seeing in black and white. When we get outside of our atmosphere we can see the world in full color.

It is possible to construct a telescope of useful size, together with its supporting equipment, to be carried in an orbiting satellite weighing a ton or so. Stabilization of the satellite itself will be difficult but it appears that the task is straightforward.

As we increase our space-travel capability, we will need rocket engines more powerful than those required by the ICBM. Development of these engines—and our current thinking is with respect to a rocket engine with a million pounds of thrust—is a task that NASA will need to undertake, and we will see that it is undertaken.

When it comes to man-carrying space craft, there are a number of possible design approaches that merit active study. One of the simpler concepts would make use of a shape very much like the blunt-nosed warhead of our ICBM's. Controllability of such a space craft, upon return to earth, would be only rudimentary. Another approach would use a design with wings, in appearance not unlike the pictures of the airplanes of tomorrow that we occasionally see in the Sunday supplements. If we are content to attempt recovery after landing "somewhere in the Pacific," then the simpler of these concepts will suffice. Somewhere in the Pacific is somewhat too broad. I think the area would be less than that, but it would be some hundred or more miles square. On the other hand, if we need sufficient controllability to permit landing more precisely, say within the confines of Rodgers dry lake in California, then the winged vehicle may be needed. And it is a very difficult task with a winged vehicle. It will, however, pose aerodynamic heating problems of great magnitude. Systematic studies of the various design shapes possible will be necessary using such of our research equipment as electric plasma jets and entry simulators, high-speed wind tunnels, and highly instrumented, rocket-propelled models. In addition to these problems, there are others, also very difficult, including tumbling and deceleration, that will have to be solved.

Regarding development of man-carrying space craft, I expect we shall wish to progress from the model stage to full-size automated craft which, after their practicability has been demonstrated, will have animals as their first passengers. I, for one, will be extremely reluctant to send men into space until their craft have been sufficiently proved to give them a much better than 50–50 chance to survive.

In the final analysis, the speed with which these programs are carried forward will have to be determined by the Congress. I cannot, however, refrain from the observation that in Soviet Russia a very large effort is being made to establish for that nation a position of world leadership in space exploration and space exploitation. If our own national space program is limited to actions that, comparatively speaking, are too little and too late, we can be foreclosing the future, so far as leadership by our children is concerned.

I should like to echo the thought expressed by Dr. Killian and his committee, that we should be "cautious and modest in our predictions and pronouncements about future space activities * * * and quietly bold in our execution."

I should like at this time to clarify the meaning of the word "Advisory" with respect to its significance within the name of the National Advisory Committee for Aeronautics. I think that in previous testimony there has been confusion about this point. For the past 30 years, the name of the agency has been a misnomer. The NACA is an operating agency; it is not an advising agency.

When the Congress established the NACA in 1915, one of the responsibilities assigned to the new agency was that, in addition to directing the scientific study of the problems of flight, with a view to their practical solution, and in addition to determining the problems which should be experimentally attacked, the new agency was directed to, and I quote, "discuss their solution and their application to practical questions."

For the first 10 or a dozen years, the NACA—the Committee, the NACA's board of directors if you will—was very active in the business of giving advice. For example, in 1916, it strongly recommended that the Post Office Department establish an airmail service on an experimental basis, something that was begun 2 years later when Army pilots flew the mail between Washington and New York. In 1917, acting in this advisory capacity, the Committee led in breaking the patent bottleneck that held back American aviation progress. Again, in the twenties, the Committee gave advice that resulted finally in passage of the Air Commerce Act, the "legislative cornerstone for the development of commercial aviation in America." From that time on, the NACA could and did concentrate on its prime responsibility—the conduct of aeronautical research.

During the past 30 years, the technical staff of the NACA has frequently been called upon to serve in a consulting capacity on aeronautical matters. We stand ready to consult with the military services and the industry on technical matters; we have not told other people what they should do.

For example, this past year the Air Force had the very difficult task of deciding which of two well-qualified companies should be awarded the contract to build the new Mach-three bomber (2,000 miles per hour), the WS 110–A later designated the B–70. The NACA worked very closely with each company. Each design incorporated the latest

of NACA research progress, but this was because the companies saw how to make good use of the new NACA research information rather than because the NACA told them what they should do. The NACA consulted with the Air Force throughout the year on technical questions pertaining to the supersonic bomber concept, but at no time did we advise as to the superiority of one entry compared with the other.

Since the end of World War II, the research effort of NACA has been concentrated increasingly on problems affecting missiles and spacecraft, and today, more than half of our work is in such areas. In 1952, one of our research scientists developed a "blunt-nose" concept for the design of missile warheads. This breakthrough results in as much as 99 percent of the tremendous heat produced during the reentry phase of missile flight being dissipated back into the air without entering the structure at all. The warhead design of every ICBM and IRBM in the United States today makes full use of this concept. It will be important also when spacecraft are designed capable of returning to earth.

Intensive NACA research has been done on the structural problems of more than a dozen missile projects. Similarly, NACA has done important research evaluating materials used in the nose cone of missiles, during enentry conditions, as in the case of Polaris and Jupiter. Much NACA work has been done on high-energy fuels, such as fluorine-hydrogen, for rocket motors.

NACA help has also been given on problems peculiar to specific missiles. This type of research project is undertaken by NACA at the request of the Air Force, Navy, or Army, whichever service may be sponsoring the missile that may be in trouble. For example, in early flight tests of the Jupiter, fire and explosion destroyed the missile soon after the rocket was fired. Tests in one of our large supersonic wind tunnels made possible identification of the trouble, and suggestion of the remedy. What was happening was that hot exhaust gases were eddying back up inside the rocket-engine structure where they caused fires or explosions. It was NACA research that provided the solution.

Today, the staff of the NACA, scientists, and engineers, and supporting personnel, numbers nearly 8,000. Problems of flight are studied at our research centers at Hampton, Va.; Moffett Field, Calif.; and Cleveland, Ohio; as well as at smaller field stations at Wallops Island, Va.; Edwards, Calif., and in the near future, at Sandusky, Ohio. For the past 30 years, our mission has been the doing of research. We have done much to extend the frontiers of flight. Today, in the face of the new challenges of space technology, we feel we have just begun.

In the effort to bring to you something more than words, and to give you some physical idea of what NACA is doing in two projects, we have brought into the room the balloon-like satellites which are intended to be launched into orbit sometime within the future. We have inflated a 30-inch satellite which weighs one-fourth of a pound, about 4 ounces, which can go in the Vanguard-type of satellite.

We have also brought into the room a 12-foot satellite which weighs 9 pounds which can go in the present Explorer-type satellite.

The model on the table is the model of the front end of the Explorer. You see in the base of it the same 12-foot balloon folded, of

the same dimensions as the inflated one, and with a little bottle of gas to separate it from the rest of the satellite and inflate it.

In the front end of this model is the so-called retrorocket. The idea is, when the satellite is put into the elliptical orbit, when the point fartherest from the earth is reached, the so-called apogee, to use the technique developed by Dr. von Braun, so-called "Kick in the apogee" to give it a little extra speed to maintain the greatest distance from the earth.

This particular satellite, if we succeed in getting it into orbit with the nearest point of approach about 425 miles and the apogee at 800 miles, would be expected to have a life of about 40 days.

The object of this experiment primarily was to see what the air density or air drag is at these high altitudes and a very light, large object will be retarded much more rapidly than the heavier metal satellites.

In fact, since you have in orbit also the final stage rocket which put the satellite in orbit, which slows down, very, very slowly, simple measurements on a photographic plate of the relative distance between the light balloon and the heavy rocket motor and the way that changes in time, will give you a very quick measure of what the retarding forces are at these high altitudes.

A second objective of this type of satellite is its use in the study of radio and radar communications by reflecting radio and radar waves from such an object.

We have under design a balloon of this type 100 feet in diameter, which would weigh about 75 pounds. While the 12-foot balloon can probably be seen fairly readily at dawn and dusk, the 100-foot balloon would be visible to the naked eye to everybody everywhere, so there would be a third advantage, a psychological one of putting into orbit something which everyone could see and would not be dependent on receipt of radio signals or anything else to prove that it was there.

We also brought into the room a demonstration model of an ion jet, which is in Washington for scientific exhibit at the National Academy of Science next week. There has been discussion of this kind of powerplant in previous hearings.

I again sought to make it a little more than words. In this ion jet we use ions formed from cesium vapor. The model has a little paddle wheel to show you that there is a jet.

This particular model is not suitable for space. It is operating at a pressure equivalent to an altitude of a few hundred thousand feet, but we have made paper studies of the present outlook for what could be done with ion jet motors and it runs something like this:

A motor which would develop a thrust of only 10 pounds would weigh 10 tons. This is a present estimate.

You see, even this apparatus is connected to the powerplant of the Potomac Electric Power Co.

In the satellite you don't have this available. It has to provide its own source of energy. It has to come from burning fuel in the form of jet fuel or gasoline or from nuclear energy as we develop these suitably small light powerplants of this type, or perhaps it eventually, if we don't need too much power, might come from solar energy.

But at the present estimate an ion motor would weigh about 10 tons to give you 10 pounds thrust.

This is the order of magnitude. Some studies have been made of vehicle design using such an ion motor. These are paper computations.

Of course, if you make very high jet velocities, say, you made the ions go very fast, the energy requirements are very large, you have to have a much bigger source of power.

So, such studies have shown that the acceleration that could be obtained by ion propulsion in a space vehicle might be as low as 10 to the minus 50 times gravity.

One one-hundred-thousandth of gravity. It is obvious, since to take off from the earth you have to have a force greater than the surface gravity, that an ion system is of no use in the early stages of flight. In fact, a little computation will show you it is no use at all until you get a half million miles away from the earth. You really get out well on the way toward Mars.

For this reason, we do not have any crash projects to develop ion-propulsion powerplants. They will not be needed for some time. This subject will remain in the research stage.

We, and others in the business, will try to invent new ideas that will reduce this weight for a given thrust.

You, perhaps, have also heard about the so-called use of solar power with the photon sail. Again a few simple computations will show you that for 10 pounds thrust you need a sail which has an area of 50 million square feet. That is quite a sail, and that sail will weigh 75 tons, even though it is made of very thin foil material much thinner than the foil of these balloons.

I bring this out simply to try to show something, instead of words, to show you that these ideas which men are thinking about are not something that justify jumping immediately into a program to develop engines. None of these will be of any use until we are out a half million or a million miles from the earth.

This, I think, is all of the prepared statement I wish to make, Mr. Chairman, and now I am ready for questions.

The CHAIRMAN. Dr. Dryden, you know about the statement made by Dr. von Braun that one of the projects about propelling a man into space about 150 miles and bringing him back, and you made some kind of an off-the-cuff, I assume, observation about shooting a young lady from a cannon.

Dr. DRYDEN. Yes, sir.

The CHAIRMAN. Do you want to amplify that, or clarify it, or explain it, or anything you want?

Dr. DRYDEN. I think I should amplify the statement.

The remark, of course, dealt with the problem that there were a large number—I said 200; I hope you don't ask me to write down 200—I see my friend Jim Dempsey said on television 60 projects to get a man into space. There might be 60, but I might have trouble getting 200.

I mentioned this to show the great number and variety of proposals, ranging from the very simple proposals to those of actually putting man into a satellite orbit.

The simplest experiment which has been proposed by many people, and at least two people in my own organization tried to interest me in going ahead with such a program—there have been many proposals for this simple experiment is using the boosters that will be available

very shortly to toss a man vertically upward and then to recover him by the use of parachute or equivalent device.

Now, scientifically this gives you one result. It gives a period of weightlessness for the man of a few minutes, as compared to a little less than a minute that we now get in flying airplanes in a curved path.

Conceivably, there are certain items of equipment that could be tested. This simple experiment, however, does not throw light on the most difficult and key problem of the man in space, which is getting him back from space or satellite orbit safely. In this latter case, we have to begin with a speed of about 18,000 miles per hour.

Many computations have shown, even Russian computations which we have seen have shown, that this can be accomplished without burning the vehicle up only by entering at a very flat angle, a few degrees from horizontal, coming in, and spiraling down. It is not possible to reenter the atmosphere vertically from satellite speeds or from space.

In vertical probe, the man and his container come to rest with respect to the earth, and then he falls freely and, depending on the altitude to which you propel him, he will reenter at speeds of 1,000, 2,000, or 3,000 miles per hour. These conditions are quite different from the reentry from a satellite vehicle, so that this experiment does not give you information along that line.

The estimates of cost vary. What I have said, and I don't change the statement, is that this simple experiment standing alone as an objective, to me, is not of very much greater value than the shooting of a lady from a cannon. It does give you a little scientific information at a great deal of cost. It may be justified as part of a very comprehensive program.

Dr. von Braun and General Medaris are people that I have a great deal of respect and admiration for. They have outlined a comprehensive program of space exploration with a cost estimate of a half billion to a billion dollars, as I recall it. Whether this simple experiment can be really justified as part of that more comprehensive program is something which should be studied as to whether the results obtained are worth the cost.

A simple extension of this kind of experiment tosses a man like a ballistic missile and does simulate a lower part of the recovery path of the satellite.

Although that is a somewhat more difficult problem, it might be that this is the place to begin. In any case, as I said in my statement, I think this must be preceded by a thorough testing out of the vehicle before we put the man in it.

The CHAIRMAN. No question but what they feel the same way.

Dr. DRYDEN. Yes. My statement was not directed in criticism of any specific program, but was intended to illustrate the wide variety of simple experiments, which give you little information, to much more complicated and costly experiments which give you a great deal more information.

The CHAIRMAN. Some people thought, assuming an agency were established and you were appointed the Director, the head of it, that it might indicate the state of your mind on your part where you are more wedded to the past activities of your organization than the future activities.

Dr. DRYDEN. I hope it is not so interpreted. I think the new Agency will be faced with the problem that they will have, through the Appropriations Committees of Congress, a certain amount of funds to be devoted to this effort. Then you will have to study the comprehensive programs and cost, and match the funds to what you can do to those things which will give you the most information.

The CHAIRMAN. What other research activities of the United States Government, not now a part of the NACA, might properly be combined into a high level organization to promote space developments?

Dr. DRYDEN. The only thought that we have given to this subject is in accordance with the President's instructions to study with the Department of Defense the activities that might possibly be transferred.

Now, this has not progressed far enough to really make any statement about it. Let me put it this way, Mr. McCormack: There are people engaged in these programs. They are highly competent, qualified, and technical people. I think it would be very unfortunate if the establishment of this new Agency had the effect of throwing all this into confusion, of stopping present activities.

I think the bill is written as broadly as it is in order to permit the working out of arrangements so that, for example, any group that you choose to name, Dr. Pickering or Dr. Hagen, so that the mechanism can be found to permit the utilization of those groups. In some cases, it may be by transfer to the new Agency. In other cases, it may be by transfer of funds from the new Agency to existing groups. We have not looked at the whole United States Government.

We have taken the view that space is a very large subject. I am not quite so sure that it would be wise to think that you are going to concentrate all space activities in one place. You are setting up a central coordinating agency, an agency for leadership.

I have already mentioned in my statement the Atomic Energy Commission. Certainly, we would urge to continue the development of nuclear propulsion for use in space. This is part of the function which they have. We will expect them to continue. The idea of transferring projects from the Atomic Energy Commission, for example, would not make any sense at all.

The CHAIRMAN. Why should not the two agencies be merged, NACA and AEC?

Dr. DRYDEN. Now, you are getting into a matter of very high Government policy. I am not sure that you will get any efficiency or advantage in a merger, in actual merger; both agencies are, at present, independent agencies and are coordinated by the White House. Now, whether anything is to be gained by putting them together under one name, I, personally, would doubt, although I am not speaking for the administration on this particular problem.

The CHAIRMAN. By the way, who drafted this bill?

Dr. DRYDEN. This bill was drafted in the Bureau of the Budget. Mr. Dembling, of my staff, was present at a good bit of the discussions.

The CHAIRMAN. A little bit, you say?

Dr. DRYDEN. We had an input. It was prepared by a group within the Bureau of the Budget into which NACA could put its ideas. But the bill is an administration bill and written by the President's staff.

The CHAIRMAN. How much were you consulted?

Dr. DRYDEN. On a half dozen occasions, there were discussions of various points in the bill.

The CHAIRMAN. Now, the draft from the Bureau of the Budget seeks to solve the problem of civilian control. You notice I use the words "seeks to solve the problem of civilian control." But it does not, in fact, solve the problem, does it?

Dr. DRYDEN. I do not know what you mean to imply by civilian control.

The CHAIRMAN. It does not provide for an overall national control of outer space by our Government?

Dr. DRYDEN. It does not. It reserves the military functions to the Department of Defense, and I think this is a wise decision.

The CHAIRMAN. I just want to get information, and I am glad to get your opinion.

Dr. DRYDEN. The civil side is in the new Agency.

The CHAIRMAN. And it does not solve the problem at the intertional foreign-policy level.

Dr. DRYDEN. The foreign policy of the United States is a function of the State Department. There is a brief reference, I believe, in the preamble of the bill, No. 6, one of the objectives:

> Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof.

The CHAIRMAN. How would you carry that out, assuming you are the Director?

Dr. DRYDEN. Of course, at present, this subject of international cooperation in space is being examined at very high levels in our Government. I do not know what the mechanisms might be exactly. As I see technical cooperation in space exploration, there are several possibilities. In the first place, we are going to have to have observations all over the world. Certainly, collaboration with nations in taking observations on satellites is one form of international cooperation.

Another possibility is to join with them in programs. This covers some of the problems, and will depend very much on the nature of the political agreements that may be worked out with respect to international activities in space.

The CHAIRMAN. That is something that can be taken care of, if necessary, when we are writing the bill. Would you think about that, as to whether or not additional language is necessary in any bill we might report out?

Dr. DRYDEN. Yes, sir.

The CHAIRMAN. I did not intend to go lengthily into the subject, but simply to call it to your attention so that you and your associates might be thinking about it and give us any additional language from the benefit of your thoughts.

Dr. DRYDEN. All of the discussions have contemplated that NASA would engage in what international activities are agreed upon as a result of the activities of the other agencies in the Government charged with international relations.

The CHAIRMAN. For example, the NASA could not take a project away from the Army, or Air Force, unless the Defense Department concurred.

Dr. DRYDEN. Only with the concurrence of the Department of Defense.

The CHAIRMAN. You have no control over military activities, such as sharing information under the IGY program?

Dr. DRYDEN. I do not think this has been any problem, Mr. Chairman.

The CHAIRMAN. I am addressing my questions now to the solution of the problem of civilian control. What would you think about writing into any bill a liaison committee between any new agency established and the military and the AEC?

Dr. DRYDEN. I think that the present method of liaison works extremely well, in which representatives of the agencies on the top advisory committees and on the technical advisory committees and, in addition, we have liaison officers in the Air Force at our existing laboratories. We have many visits back and forth. Now, it is possible to organize this liaison in a very formal way. I think the present method has worked very well. I think the other method will work, also.

The CHAIRMAN. Is there authority in the bill for research in connection with space exploration, for the actual space exploration on the part of the new Agency, if established?

Dr. DRYEN. As I read the bill, that power is contained there. I do think that there is going to be a practical problem as to how many agencies are permitted to put up satellites. It certainly will be quite a job to keep track of them all.

I have already said that I think, on any experiments made, for example, with the present power boosters, probably, we would contract with Ramo-Wooldridge Corp., or to arrange with the Air Force to do the actual firings.

I would say the bill provides great flexibility in the manner of carrying this out and, certainly, it would be entirely possible to contract to private industry or anybody else to do the actual work.

The CHAIRMAN. Yesterday, Dr. Hagen expressed the doubt as to whether the language of the bill was comprehensive enough in that respect. I called his attention to the fact that I thought it was.

Dr. DRYDEN. Yes. I will have to leave this to my legal friends to decide. I thought it was.

The CHAIRMAN. I have one more question. There is a lot of opinion that this should be on a Cabinet basis, Cabinet level. What is your personal view on that, not your official view?

Dr. DRYDEN. I think there are some questions as to whether it should begin that way. I think that space exploration will start in a more modest way. Perhaps we should wait and see how it develops before we consider making it a full Cabinet department.

The CHAIRMAN. What about making it a commission of five, like the Atomic Energy Commission?

Dr. DRYDEN. I think the commission form of organization is subject to certain difficulties arising from the determination of the relative authority of the members of the commission and the lines of authority I think that, generally, people who want to work together rise above organizations, and any method of organizations can be made to work if people want to make it work.

The objective of the bill is to provide a clear and undisputed line of authority from the President to the director and the board, which,

in the present organization of NACA's executive group, is, in a bill, reduced to an advisory function. So that the object of the bill is to be sure who has the authority, who is to be held responsible. I think, with a commission form, you do have a little more difficulty along this line.

The CHAIRMAN. If the substance of this bill should be finally enacted into law, what level in relation to the President, assuming you are a Director, would that place the Director in?

Dr. DRYDEN. At the present time, the President of the United States is very much interested personally in the space program.

The CHAIRMAN. I mean by law, now.

Dr. DRYDEN. By law it means that like any other agency, an independent agency, it will be responsible to the President.

Now, the personal relationships depend on persons.

The CHAIRMAN. That is true.

Dr. DRYDEN. I don't know how you can legislate this.

The CHAIRMAN. That is true; we understand that.

Would this put such an agency on the level, for example, of the National Security Council?

Dr. DRYDEN. I think we have to clarify the meaning. At the present time, Jimmy Doolittle can go see President Eisenhower on any matter of importance to the NACA. I can go see the President if we think it is important enough to bother him about it.

In the past few years we have seen the President several times on matters regarding the NACA.

The CHAIRMAN. That is not involved in my state of mind. I just wanted to get your opinion as to the practical operation. At what level would the Agency be?

Dr. DRYDEN. Some agencies are members of the National Security Council.

The CHAIRMAN. Do you think you should be if this bill is put through with the Director?

Dr. DRYDEN. Again it depends on the importance and the level to which this Agency grows. At the present time, I am involved, or our Agency is involved, with the Security Council in this way: When a question arises which pertains to our Agency, the field of our Agency, we are called in to special committees to deal with that.

I would expect that on any question of space that the National Security Council takes up, the heads of the Agency would be brought in whether he is a member of the National Security Council, or not.

The CHAIRMAN. You want the Civil Service Classification Act waived?

Dr. DRYDEN. This is a very important question and I think I would like to say a few words about that.

The CHAIRMAN. The only reason I raise that is, What effect would that have on scientists and technicians in other activities who are covered by the Classification Act?

Dr. DRYDEN. I think in a majority of cases they would be glad to see some escape from the dilemma which the Government now faces. Because of the Government's scale, which is something like $1,500 to $2,000 a year below the market at the medium levels and very much higher than this at the top levels, the Government finds great difficulty in obtaining competent people.

The new agency would not be able to operate at all if it is going to run a contract laboratory with a private scale and to run its present institutions with the present civil-service scales.

Every one is going to go to the contract agency. It will be impossible to run this mixed organization.

What this bill proposes to do is to preserve these teams which have been built up over many years in the Government, the facilities which have been built up in the Government, to preserve that asset in the new organization.

It cannot work in the team with contract organizations of two different salary scales. At present half of our people are paid competitive compensation. Those are so-called blue-collar people, although I do not like that designation of it. Their salaries are determined by wage surveys.

We have the problem even now at the borderline where you may find a blue-collar man in what might be considered not anything like a professional position getting more than the professional people.

We are proposing the extension of this principle to the professional people and, very frankly, I would hope and I am sure there are many scientists with responsibilities in the Government who would hope this would be a forerunner of such action for all agencies.

The CHAIRMAN. I have no objection to it. In fact, I can understand it.

My questions are not from a critical angle, but I can see where if we give this privilege to the new Agency and then Dr. von Braun and Dr. Hagen and others who have scientists and classifications who are bound by the Classification Act, that it would raise some very embarrassing situations from the angle of relativity.

Dr. DRYDEN. This question, of course, has come up before. A year or two ago we were losing large numbers of capable people. We went to the Civil Service Commission. Congress had given the authority to fix salaries in periods of shortage. We got the so-called top-grade adjustment for the people in the aeronautical research categories.

There is some dislocation in other agencies but that principle has been extended into other fields. Most of the people are quite willing to see somebody pioneer in doing something about what is really a very definite handicap.

Many of the new activities in the Government are being organized under the contract system, actually persuading somebody not already in business to set up a corporation or to set up a special corporation to run the organization under contract to avoid these difficulties.

Now, conceivably, we could run our current laboratories under contract by setting up holding corporations to run them. It would cost the Government much more money and the bill as proposed attempts to set up an organization that can function with one part of it under a contract organization, the other preserving the existing teams and staff that have taken so long to build up.

The CHAIRMAN. Should not the provisions of this bill be extended right across the board?

Dr. DRYDEN. I would hope that it would be.

The CHAIRMAN. That is the thought that came to my mind.

Dr. DRYDEN. I am prepared to discuss this with the Civil Service Committee. They are interested in this particular provision and we are prepared to discuss it with them.

The CHAIRMAN. Mr. O'Brien?

Mr. O'BRIEN. Mr. Chairman, I might make an observation. It seems to be easier to send a scientist to the moon than to maneuver him around the Classification Act.

Doctor, you stated you had a series of instructions from the President and the fourth instruction was:

> To review jointly with the Department of Defense pertinent programs currently underway or planned by the Department of Defense and to be recommended to the President which of the programs should be placed under the direction of the new NASA.

Dr. DRYDEN. Yes, sir.

Mr. O'BRIEN. Then I assume in writing the bill that was covered by the statement that these activities would be directed by a civilian agency except where they may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with or on behalf of the Department of Defense.

The question is this: If these activities are peculiar to or primarily associated with weapons systems or military operations, why should they not be directed by the Department of Defense and why should there be this question of acting on behalf of the Department of Defense?

Dr. DRYDEN. I think perhaps that language does not express the intent. I mentioned our cooperation with the Department of Defense on the bomber project, for example, and now the objective of this language, which may not be the best possible language, was to permit such collaboration of continue and to be done in the space field as well as in the aeronautics field.

Perhaps these words "on behalf of," which I personally did not write, is not the proper expression, but the intent was that Defense and the Agency could collaborate on military programs as well as Defense could collaborate on civilian programs.

Mr. O'BRIEN. Doctor, I have noticed testimony from you and the other distinguished gentlemen who have been here, that there is a reference to the military use of this space technology, and then each has mentioned the peaceful uses.

Dr. DRYDEN. Yes.

Mr. O'BRIEN. That is including civilian scientists as well as the military men.

But I rather get the impression that any peaceful developments would be largely a byproduct of the military exploration, sort of a fortuitous development. Am I correct in that impression?

Dr. DRYDEN. Yes; I think that there are certain "clearly recognizable peaceful uses," let us say, to borrow this term, for space. It is hard to think of any peaceful activity that the military is not concerned with at some point. I think you will see my difficulty in a moment.

Mr. O'BRIEN. I do. I have in mind such things as weather and communications.

Dr. DRYDEN. The weather and communications are the two which come very much to mind. Weather is, of course, of interest to the military as well as to the civilians. The Weather Bureau, Dr. Reichelderfer and all of us, foresee the possibility of greater improvement in weather prediction, possibly weather "control."

This is a word we use, we don't really know whether we can control the weather, but certainly weather prediction.

At the present time all we know about the weather is on land. We send up some probes and get a few observations.

Four-fifths of the land is covered with water and we get a few observations from ships and that is all.

With satellites we can look at the clouds over the whole world.

Mr. O'BRIEN. Would you say, then, that weather perhaps is the most feasible of the peaceful possibilities for early development?

Dr. DRYDEN. Communications run very, very close to this. If we can put up things 100 feet in diameter and maintain them, it looks as if very great advances in worldwide communications can be made.

Mr. O'BRIEN. That leads to my final question.

Are any of these peaceful possibilities at a stage now warranting a special project designation and appropriation, or are they to come later as a result of these over-riding military necessities?

Dr. DRYDEN. I thnk they should be started now. Let me distinguish. We first have a bit of a research job. We have not yet fired a satellite that looks at clouds. So there is the problem of the development of means. By just as soon as the means are clear, then I think we are ready to proceed.

Now, whether this activity would be carried on as a service to the Weather Bureau, whether the Weather Bureau would do it directly, is a matter for determination.

Mr. O'BRIEN. Assuming any of these things reach a feasible stage, you would more or less break loose and go into that field?

Dr. DRYDEN. Yes.

Mr. O'BRIEN. Thank you very much.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Dr. Dryden, as I understand, generally you agree with the provisions set forth in the bill under consideration by the committee?

Dr. DRYDEN. Yes, sir.

Mr. NATCHER. I want to direct your attention, Dr. Dryden, to page 3 of the bill, providing for a board of 17 members.

Dr. DRYDEN. Yes, sir.

Mr. NATCHER. A great number of people have expressed opinions during the past 2 weeks and a number of witnesses before this committee, that a board composed of 17 members will not be workable, the number is too large.

How do you feel about that, Dr. Dryden?

Dr. DRYDEN. Let me point out that the board is advisory, that in the history of our own past practice we have never permitted committees to get into the administrative line and hold up actions. They are forums of people of great wisdom and experience who sort of keep us in a goldfish bowl and with whom we can discuss problems.

Now the space business has such ramifications that I do not think you can get away with les than 17 people if you want to see on there the necessary board representation.

For example, it is provided that there be eight members from Government. You certainly would want someone from the Atomic Energy Commission; you would want someone from the National Science Foundation; you would want someone from Defense. You would probably want someone from the Air Force, Army, and Navy.

You see, you are already getting into numbers.

Now let me tell you the advantage of this in a very graphic way. At present we are just beginning to put civil jet transports into operation and the Civil Aeronautics Administration has the job of regulations applying to these jet transports. So they come to us for technical assistance and advice. They would like us to fly some jet transports and make some measurements so they can put some numbers in their regulations.

In a meeting that just came up General LeMay was sitting in for General Wright as a member of the NACA Executive Committee and in 5 minutes he had arranged for the loan of a jet tanker for the experiments in which the CAA was interested.

This is the kind of direct action you get from having the proper kind of Government membership on your advisory committees. You can shortcircuit an awfully lot of negotiations.

Take the other membership that has always been on the NACA, the president of the National Academy of Sciences, in fact, top scientific people generally. We have had men of considerable distinction in the aeronautical field. Space is going to require propulsion people; people concerned with vehicles, people concerned with electronics, people concerned with medicine.

To my mind it is necessary to have this number in order to have people who can reflect the points of view of the various disciplines that are concerned with space.

I should like to emphasize again, as the bill provides, these are advisory. It does not say that actions are channeled, we do not now channel administrative actions through advisory committees. We think we know how to use the advisory committees to good advantage.

For my part I support this completely. In fact, I personally have felt that maybe the committee was not quite strong enough in that they are not a policy-fixing body.

The CHAIRMAN. You mean the board of 17?

Dr. DRYDEN. Yes. At the present the NACA board is a policy-determining body.

The CHAIRMAN. You are under them?

Dr. DRYDEN. I am responsible to them, yes. They deal only with policy. They do not deal with detailed operations at all.

Like the board of directors of a company——

Mr. NATCHER. How many numbers do you have on them?

Dr. DRYDEN. Seventeen; the same number.

The CHAIRMAN. The theory of the new agency is to have somebody with responsibility?

Dr. DRYDEN. That is correct.

The CHAIRMAN. Your statement now is a contradiction of what you said before?

Dr. DRYDEN. No. I have said that we have had 40 years' experience with an organization which has worked extremely well. My first reaction was that I would like to see it continue the way it was. I think there is a lot to be said for this fixing of authority.

The present bill does fix the authority in one person with the advice, however, available to him of distinguished men who are competent in the various technical fields.

I think that is a good arrangement. It accomplishes the purpose of fixing the authority, but it does preserve the goldfish bowl contact, if you like, with people who know the game.

The CHAIRMAN. I am not arguing; I am inquiring.

All right, Mr. Natcher.

Mr. NATCHER. Dr. Dryden, the bill further provides that the director shall be appointed by the President and confirmed by the Senate. What type of individual should the director of this particular agency be, Dr. Dryden?

Dr. DRYDEN. I think, first of all, he has to be a pretty good administrator to run this complicated show with relations with Defense, with contracting agencies, with people within Government laboratories, with scientists in the country. It is quite a team here that we must use in our country to get this job done.

You cannot isolate a bunch of people and have them do it all. He must know something about the subject.

I am not in favor of managers who do not know anything about the thing which they manage. So you have to find people with both qualities. They may have started life as managers and learned science and technology, or they may have started life as scientists and learned administration.

I think these are the two sources of such people, but they must have competence on both sides. Those are the principal qualifications.

Mr. NATCHER. Would you recommend, Dr. Dryden, that the director be a scientist?

Dr. DRYDEN. Not if he is only a scientist. I have tried to make this very clear.

Mr. NATCHER. In other words, he must have administrative ability?

Dr. DRYDEN. He must have administrative ability as well; yes, sir.

Mr. NATCHER. Do you agree with Admiral Rickover's statement concerning the qualifications of a director; he should be a right good politician? How does that sound to you, Dr. Dryden?

Dr. DRYDEN. Well, I use the word "public relations," or something of the kind, not only to deal with Congress, but many other different kinds of people.

By the way, may I go on to say that I think the attempt to use a political solution of detailed technical questions is wrong. I think that politicians or statesmen, as I prefer to say it, do have the responsibility for making decisions which involve other factors. This is a thing which we have learned.

I mentioned the collaboration with the Air Force. The decision as to what contractor should build a vehicle involves a great deal more than scientific or technical considerations.

You gentlemen have to deal with many more aspects than the purely technical ones.

Mr. NATCHER. You point out in your statement that the NACA is an operating agency and it is not an advisory agency.

Dr. DRYDEN. That is correct.

Mr. NATCHER. And further, it was established, of course, in 1916. Now, Dr. Dryden, do you not have suggestions today in your own mind as to provisions for bettering the present NACA organization from the standpoint of organization and authority that are not presently a part of the law that controls NACA?

Dr. DRYDEN. Yes, I think that the bill which is before you is very much broader than the law which relates to the present NACA.

Mr. NATCHER. You think that the present NACA would function much better if they were operating under a similar bill as the one that has been presented to the committee?

Dr. DRYDEN. Yes.

Let me be a little more specific about it. Our past activities have been essentially research activities, applied research activities. This bill puts us into two new fields for the existing NACA. One is hardware development.

We at present make no contracts with anybody to build airplanes or missiles. This would put us in the business of making contracts with industry to build certain types of vehicles for us.

The other is the area of rather large operations. To do this, the internal structure, the structure below the director, must be changed. We must go through our organization and make changes in the organization. That is not giving the space job to NACA. It is building a new agency, preserving the staff facilities and values of the present NACA and giving it very much broader authority than it now has and much greater flexibility in operation.

Mr. NATCHER. Mr. Dryden, I thank you.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Dr. Dryden, I would like to pursue a little bit further this organizational setup.

Do I understand that you have taken a position that you favor the proposed 17-man board of this bill before us?

Dr. DRYDEN. I do.

Mr. SISK. You would do that as opposed to, for example, a 3- or 5-man commission?

Dr. DRYDEN. I would.

Mr. SISK. In your opinion, Dr. Dryden, what would be the difference in lag time between the determination of a policy or the expediting of a program? Do you feel that a large group of this type, and of course, I believe in your statement you mentioned a group in your present operation of some 500 people.

As I recall, I believe you mentioned an occasion where meetings, certain meetings, were held, discussions that occurred with reference to a particular program in 1952, and I think finally contracts were let in 1955.

I appreciate the things that had to occur there. Yet at the same time, do you feel that our desire to expedite some of these problems is due to, let us say, political necessity, and understand, I am not speaking in the narrow partisan sense, but the world situation, would put too great a stress on a group of this kind?

Dr. DRYDEN. I think this group does not make the determination that you are speaking of. Perhaps again I should make it clear what such a body does.

They are a group of kibitzers, if you like. The Director has full power to make decisions. He does not wait for the Board to meet; he goes ahead and acts.

However, these people look at what he is doing. If they support what he is doing they render the very valuable service of people not a party to the decision coming to you gentlemen, going to the Director

of the Budget and supporting the Director in the activities that are undertaken.

By the same token, they could go and criticize. But the possible advantages we have seen in a board are that if you have a sound and sensible program, these men of affairs whose words carry great weight in the council of people on the outside have been extremely valuable.

If I present the budget to the Director of the Bureau of the Budget, I am selfishly interested, say, in building up the agency. If General Doolittle comes in from outside, who is not dependent on this for his living at all, and has looked into the matter and makes a statement to the Director of the Bureau of the Budget, it carries a weight which is very different from that of the Director.

Maybe it should not, but it is true. I think the same is true of Congress.

Mr. SISK. I appreciate that, Dr. Dryden. Of course, I think certainly we want to take full advantage of the advice and the information that we could get from, let us say, a sizable group of people, but, at the same time, it seems to me that it is important, if we propose to move ahead with any rapidity, that we have a group, and it seems to me the smaller it is, the more expeditiously it can act, that can make the decisions and have the power to do that and eliminate this logrolling that might occur and a lackadaisical attitude. Maybe that does not exist.

Dr. DRYDEN. I think you are confusing this with the way in which some other agencies would operate. The director and his staff would have the power. There is no power of decisions in the hands of the board.

You do not wait for a board to pass on everything. You do not take contracts to the board to discuss or for signature.

The board, in this case, is looking at the highly technical operations of the agency and are giving the reaction which they are familiar with, of people they associate with every day, and this is useful for guidance.

But it is not a control. They do not take votes in such advisory committees because they do not have any power of enforcing this vote.

You discuss and get different points of view.

In this agency the director will make the decisions, or he may have made the decision before and he would tell them what he had done as a matter of information, but these committees are not in the administrative side at all.

Mr. SISK. In other words, you proposed a single director who actually has full authority, he actually becomes a czar, so to speak, and these other gentlemen are more or less in an advisory capacity?

Dr. DRYDEN. They are a source of protection to you and everybody else—that he does not become an irrational, unsound czar, because they are in a position to observe.

They have access to everything that goes on and can make a noise about it if this man gets off base.

I think this is what the bill intends to provide.

Mr. SISK. Do you think that the AEC has done a pretty good job?

Dr. DRYDEN. I think the AEC has done a pretty good job. As I said before, it is an association of people concerned rather than the

organizational chart, which determines the efficiency of an organization.

Mr. SISK. To what extent do you think we are fully utilizing our capabilities so far as scientific engineering knowledge and know-how in this country is concerned, at the present time?

Dr. DRYDEN. I know very few scientists or engineers who are unemployed. There are some.

Mr. SISK. Now, the fact of their unemployment I would question. I mean to what extent are we utilizing their capabilities in the programs in which we are most interested at the moment?

Dr. DRYDEN. I think we are utilizing them very effectively.

May I say what the problem is? Everybody in this country wants to work on space. Every engineer would like to be in this field. My office is filled with letters from people who want to join this new agency.

The popular subject is one which attracts. Now, we cannot possibly support all the people in this country who would like to work on space, all the companies, all the scientists and engineers. There are other jobs that have to be done.

Now, I think there is plenty for people to do and I think as far as the present programs are concerned we are using people pretty effectively.

Mr. SISK. The reason, of course, for my asking the question is that this has been a well-discussed question throughout these hearings because there are differences of opinion as to the extent to which we are utilizing our engineering capabilities.

Do you feel that our capabilities are on a par with other nations on the earth today?

Dr. DRYDEN. Yes. I think what has been under discussion is any specific situation. You will find on occasions a certain line of work has run out and new work has not come in, a little unsettled condition at such a time, but I think we are using our people on the whole very effectively.

Mr. SISK. And you think they are fully up to a par, or ahead of, any other country in the world?

Dr. DRYDEN. So far as the quality of the people are concerned, the abilities of the people, yes.

Mr. SISK. And under the proposed legislation we can fully utilize our capabilities engineeringly and scientifically?

Dr. DRYDEN. As far as legislation goes. Of course, the question of right and what to do, depends on appropriations as well as the legislative authorizations.

Mr. SISK. I think that is all, Mr. Chairman.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. Dr. Dryden, I was interested in your statement a moment ago concerning the weather observation possibilities of satellites.

Assuming that we had the facilities for such a satellite to observe weather conditions, just how can we put that information to useful purpose here? What can we do about it? We know a storm is coming; we know it is going to rain.

Dr. DRYDEN. The immediate benefit would be in weather predictions, at the present time, especially in the western part of our country and out in the Pacific there are few stations.

As I understand it, I am not a professional meteorologist, but from ordinary pictures of clouds the major storms can be recognized and followed from hour to hour.

A satellite, depending on the altitude, goes around every 1½ or 2 hours, and you can keep a continuous record of where the storms are and how they move.

The first benefit would be in prediction. Now, all of the ideas that we will control weather rest upon the idea that first we will understand weather, what makes it, and one difficulty in meteorology now is that we have a theory, it is difficult to get enough observations to verify and check them.

We believe that the more detailed observations this will provide over the whole world will lead to a better understanding of what it is that produces storms and how they move.

Then we are thinking of course, hopefully, that we will be able to do something about the weather if we understand how it arises.

Mr. KEATING. In California, that is? That is where they need the thing most.

Mr. McDONOUGH. On the Pacific coast. We have no problems of weather in California.

What about communications now, the practical use of transmitting communications worldwide by satellite? Can you give us an idea of how that can be practically done?

Dr. DRYDEN. First the approach will undoubtedly be the one of using satellites as reflectors. In other words, you direct a radio wave to the satellite. It then is reflected around the horizon.

A great deal of communication today is line of sight, limited by the distance you can see, and it is possible to do a great deal merely by reflection.

Now, looking further into the future, we see the possibility of having relay stations, that is stations which receive and retransmit. In theory at least, you could send a message, so to speak, to this receiver while it is overhead, store it up, and when it gets around over some other station halfway around the world, it retransmits the message down to that station.

Now, this, of course, is far into the future because it takes power. At the present time the only thing we put up in a satellite is battery power or a very small amount of solar power and this transmitter will not be very much good if it lasts only a few weeks.

But later in the future we see the possibility of active relay stations.

Mr. McDONOUGH. The bill under the declaration of policy states in No. 6:

> Cooperation by the United States with other nations and groups of nations in work done pursuant to this act and in the peaceful application of the results thereof.

Do you think under that part of the declaration of policy that we should attempt to enter into a cooperative plan with Russia to send a man to the moon and thereby expedite that action?

Dr. DRYDEN. I do not know whether such an agreement can be worked out, or not. This is a matter of diplomatic policy which is far outside of my own knowledge.

I think that the American people generally would like to put space on a peaceful basis and to have all nations cooperate in exploiting

it. I just do not know whether this is a possible thing, or not. It is at the present moment very difficult to divorce space activities from military activities. We are using boosters which come from the military ballistic missiles program, the Russians are doing the same.

Now, whether under those circumstances you can get a peaceful collaboration or not, I am just not sure.

Mr. McDONOUGH. Do you agree with the statement yesterday by Dr. Hagen that there is a danger of collisions of satellites if we put too many of them into outer space?

Dr. DRYDEN. There is a lot of room in outer space. I think the chances are pretty small. I do not foresee this to be a great problem for a long time to come.

Mr. McDONOUGH. The statement later was made that if we had more of them operating it would be easier to track them than it would be to have 1 or 2 and, therefore, the information we would obtain from them would be greater.

Dr. DRYDEN. The more you have up there sending data, the more data you can get. I don't quite see why the more you have the easier it will be to track them. I would think that the more you have the harder it is.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. Glad to see you here, Doctor.

On the bill on page 2, the question comes up as to the division between civilian approach to space and the military aproach to space. On line 4 it stated that:

> The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States.

And then on line 7, it says:

> Except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of the Department of Defense.

My question is this: Why not have a civilian agency or a department that has charge of all space activities, that is, both activities for peaceful development as well as military activities.

Why divide them down the middle like this, as this legislation proposes?

Dr. DRYDEN. I believe that the primary reason for making such a division is to essentially emphasize the desire of our country to promote the peaceful uses of space, to be in a position perhaps where the military classification problem does not arise quite so seriously.

Mr. McDONOUGH. Do you not think that a United States space agency should work on an overall United States national policy for space, both military and civilian?

Dr. DRYDEN. This is a policy question, of course, to be decided. My own opinion is that when you divorce military research and development, particularly hardware development from the military, that you lose.

I am not commenting on the organization within the Defense Department. There are arguments for separating within the Defense Department, procurement from research and development, and the question is whether a civilian or military head this.

But to take the full responsibility for military research out of the military departments would, I think, be a mistake.

Mr. FULTON. I do not mean to take it out. I am talking about the setting of an overall national policy for space. I would have the applied research be in the military, but I might ask you under this bill, which is my second question, do you thing that the restriction in this bill that provides that the Department of Defense shall have such activities as may be peculiar to or primarily associated with weapons systems or military operations limit ARPA and the Department of Defense on basic research? Is that too limiting in language?

Dr. DRYDEN. I think that there is a question of interpretation of exactly what these words mean. I believe that the intent of the administration in framing the law was to make this separation so far as space is concerned.

Of course, basic research, the difficulty I have with answering the question on basic research, is that most of the basic research I know has very wide application.

It is very difficult to say that this work on high-temperature materials is done for space.

Mr. FULTON. You do not think that this language is intended to be limiting?

Dr. DRYDEN. I don't think it is intended to limit the Department of Defense in doing the basic research appropriate to its mission.

Mr. FULTON. Would you have your agency, or its counsel, submit more appropriate language.

May I ask a question on the chart of the NACA organization. You are the director and Dr. Crowley is the associate director?

Dr. DRYDEN. Yes.

(Letter in answer to above request is attached.)

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS,
Washington, D. C., May 23, 1958.

HON. JOHN W. McCORMACK,
Chairman, Select Committee on Astronautics and Space Exploration, House of Representatives, Washington, D. C.

DEAR MR. McCORMACK: During the hearings before the Select Committee on Astronautics and Space Exploration, language distinguishing the military from the civilian space programs was requested to be submitted for the record (see page 968 of the transcript).

In connection therewith, we suggest that, on page 2 of H. R. 11881, lines 9 and 10, the words "in which case the Agency may act in cooperation with, or on behalf of, the Department of Defense" should be stricken and the following words inserted in lieu thereof: "in the case of which activities the Department of Defense shall be responsible."

Sincerely,

PAUL G. DEMBLING, *General Counsel.*

Mr. FULTON. Then you have three assistant directors for research, I believe?

Dr. DRYDEN. Aerodynamics, propulsion, and structures; yes.

Mr. FULTON. Dr. Rhode is on structures, Dr. Abbott is on aerodynamics, and Dr. Rothrock is on propulsion.

Dr. DRYDEN. Yes, sir.

Mr. FULTON. If you will look at the chart you submitted, it does not have on the five categories of research programs how they fall in organization.

Would you resubmit a chart showing how it falls into the various fields of Dr. Rhode, Dr. Abbott, and Dr. Rothrock on these research programs?

May I go further. I do not see on these research programs any program at all for research study or development on photon or light propulsion.

As you know, I have been interested in that. I just have not picked that up. I would like to have a statement in the record on that.

Then on your ion rocket propulsion development, I feel that you should give a further statement because having heard you speak of the lack of practicality, there are those of us who disagree with you.

If I direct your mind to two other factors, the factor that makes the ion propulsion system so good is that while the original rate of acceleration is low, it keeps on continuing. So how long would your engine of ion propulsion type be intended to run in terms of years, and then will you please give us the rate of added acceleration during that time to give us the speed it would build up to?

Likewise, would you tell us how many materials are discharged so that we can see how the acceleration would go faster the more fuel was discharged?

Dr. DRYDEN. Yes. You can, of course, do this with a great many things.

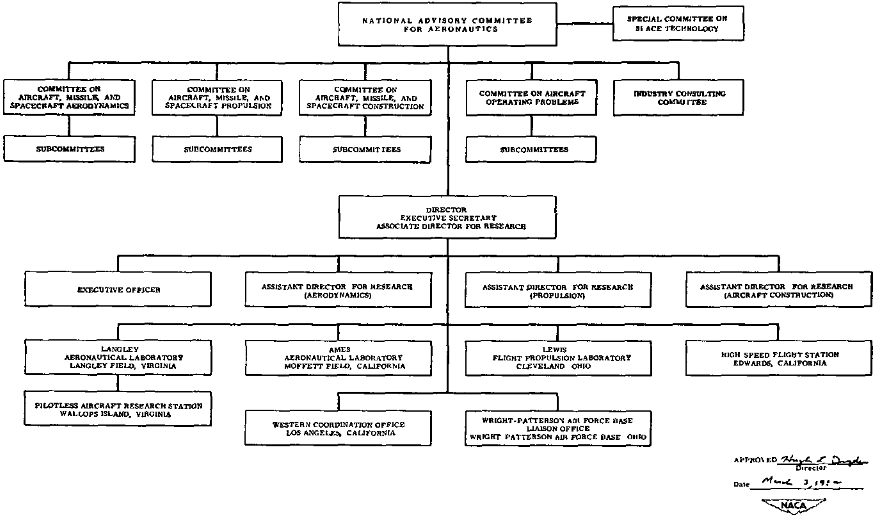
Mr. FULTON. If you will submit that for the record.

Dr. DRYDEN. All right.

(The material referred to is as follows:)

ORGANIZATION CHART

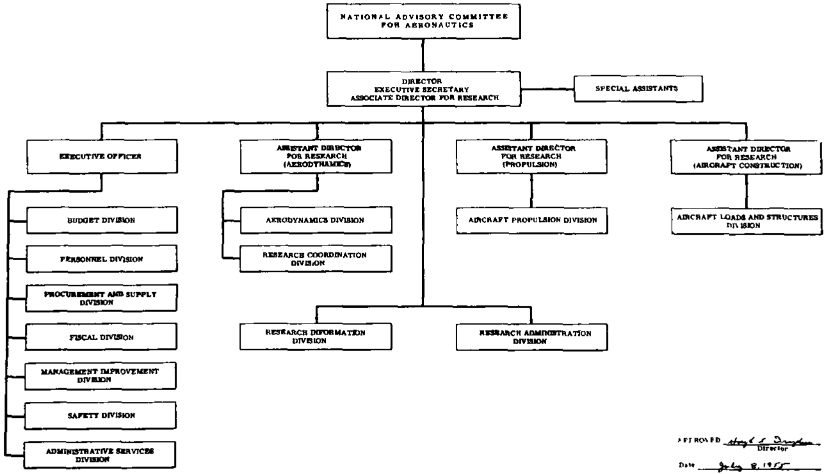
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS



ORGANIZATION CHART

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

NACA HEADQUARTERS, WASHINGTON, D C



APPROVED Hugh L. Dryden
Director

Date July 8, 1955

NACA

General Statement on NACA Ion Rocket Investigation

The ion jet is a useful propulsion system where gravitational forces are extremely small or are largely canceled out by centrifugal force. This is due to the very low thrust-to-weight ratio, i. e., 10^{-4}, of these engines. The ion jet must generate ions and then accelerate them to very high velocities, i. e., a range of 64,000 to 640,000 feet per second. Since this is done electrically, one must study methods of producing ions and intense magnetic fields and perhaps equally important, methods of producing high electrical power for a minimum weight.

The NACA has been investigating several possible ion sources, such as cesium, rubidium, and potassium, seeking a system that will require the least amount of energy to generate ions with a high level of reliability and ease of control. Ionization methods such as the electric arc, electric resistance heating, and the catalytic effects of surfaces are under study.

Studies of the means of accelerating particles involve the production and use of magnetic and electromagnetic fields of high concentration, and the use of high-velocity particle bombardment. The NACA is conducting both analytical and experimental programs on ion and plasma acceleration with the objective of finding systems of minimum weight and high reliability.

As a guide for this work, we have studied analytically the requirements for ion rockets in terms of thrust, fuel required, vehicle size, speed, and control. Work of this nature was reported at NACA's Annual Flight Propulsion Conference in November 1957.

ION ROCKET

The ion rocket will generate many times less thrust (measured in pounds) than its own weight. The ratio of 10 pounds thrust to 10 tons weight to illustrate this point has been used. A photon rocket behaves similarly. However, its calculated thrust-to-weight ratio will be on the order of one-tenth of a pound thrust for each 10 tons of weight. Consequently, both engine types are useful propulsion devices only in those cases where the gravitational forces that must be opposed are less than this ratio. Under these conditions, a very small thrust will accelerate a vehicle. However, the smaller the thrust the longer the time needed to reach a given speed. The following table gives several examples:

Increase in vehicle speed for several types of rocket engines operating continuously for periods up to 1 year

Increase in speed (ft /sec) after—	Chemical rocket	Ion rocket	Photon rocket
1 minute operation	16,000		
3 months operation		3,900	39
6 months operation		7,800	78
9 months operation		11,700	117
12 months operation		15,600	156

For travel to Mars or Venus, speed increases on the order of 12,000 ft.-sec. are needed, assuming that one starts from an Earth satellite. The operating times of the ion rocket engine will be on the order of 2 to 3 years for a round trip. The photon machine will have to run much longer to produce an equal increase in velocity.

The amount of fuel consumed or discharged by the engine will vary with the time the engine is running. The following table gives several values of the discharge rate:

Fuel discharge rate for two types of rocket engine

Engine:	*Fuel discharge, lbs.-sec.*
Ion rocket	0.0013
Chemical rocket	4,500

From the above, one may conclude that any of the three engine types can be used for space missions starting from a satellite in orbit around the earth. If a chemical rocket is used, a very heavy vehicle will result. If an ion rocket is used, a lighter vehicle is possible to carry the same payload, but the travel time involved may be considerably longer. A photon rocket would significantly increase the travel time without much further reduction in weight.

A considerable background of research information has been accumulated for the chemical rocket over the last 20 years. Much more remains to be obtained. However, enough is known so that the areas where a major effort will pay off, and the extent of benefits to be gained are fairly well defined. Consequently, it is logical to plan hardware development in anticipation of research results.

In contrast to the chemical rocket, the ion rocket is in the very early stages of its growth cycle. Very little research information is available. One can only speculate as to what are the most promising and practical types of ion rockets. It is not certain that the performance figures so widely quoted can be achieved. However, the potential usefulness of the ion rocket requires that our research programs be accelerated at top speed to verify or disprove our theories. To this end, NACA is building research hardware such as ion generators, electric and magnetic accelerators, calculating the overall performance of a number of possible fuels, and evaluating the best means of producing electrical power. There is no question that ion rockets can be built. The question is, which types and designs are worth accelerating.

NACA PATENT RULES AND REGULATIONS

Executive Order 10096, issued January 23, 1950, provided for a uniform patent policy for the Government with respect to inventions made by Government employees, and for the administration of such policy. It directed each Government agency to promulgate whatever regulations were necessary to effectuate the order. In compliance with this directive the NACA regulations presently in effect were formulated. A copy of these regulations, issued on October 1, 1951, and entitled "Rules and Regulations Relating to Patentable Inventions of Employees of the National Advisory Committee for Aeronautics," is attached. The President, in Executive Order 10096, named the NACA as one of 10 Government agencies having representation on the Government Patents Board, established by that order.

NACA regulations require that all employee inventions be reported, with full information concerning the circumstances under which they were made. If patent protection is deemed advisable and a prior art search confirms the existence of patentable novelty, a determination regarding the disposition of the rights to the invention is made by NACA, in accordance with the provisions of the Executive order. If title, or all rights are to be left with the inventor, the concurrence of the Chairman of the Government Patents Board must be obtained. The employee may appeal to the Chairman of the Government Patents Board from a decision made by NACA. The decision of the Chairman upon any such appeal is final.

Mr. FULTON. Then on gravity, of course, you told us it weighs 75 tons. I imagine that is at sea level. But, for example, if you took a ton and put it out, say, 12,000 miles, it would weigh how much, about one-sixteenth as much? And if you took it out about 20,000 miles a ton would weigh only a hundred pounds.

Dr. DRYDEN. Yes, if you carry it out to a half million miles it will weigh only one one-thousandth as much and it is only there that your ion motor gives you enough thrust to do anything.

Mr. FULTON. Then your 75 tons is 150,000 pounds and it weighs one hundred thousandth of that, so it only weighs a pound and a half.

Dr. DRYDEN. That is right.

Mr. FULTON. So that really when you are getting ionic propulsion and you talk about getting 10 pounds thrust, that is really a ratio of about 6 or 7 to 1 thrust——

Dr. DRYDEN. I must say I do not follow you. The mass is still the same which you have to accelerate.

Mr. FULTON. Ten pounds of thrust and it only weighs a pound and a half. That is, you divided the pound and a half into the 10 pounds thrust and you have 10 pounds pushing a pound and a half.

I think you had better look into it again. I think that is pretty good.

Dr. DRYDEN. I am sorry; the mass is still a hundred tons and it takes the same force to change its speed.

Mr. FULTON. Yes, but you have not commented on the fact that with the continuous exertion of 10 pounds of thrust over a period of years you get a continuous rate of acceleration which builds up into tremendous leads; is that not right?

Dr. DRYDEN. That is true. In this example I have given you, you use a ton of cesium every 47 days. This is a material you have to eject.

Mr. FULTON. All right. Cesium is a very heavy material. I think its molecular weight is 100 times hydrogen——

Mr. McDONOUGH. 137 times.

Mr. FULTON. 137 times.

Dr. DRYDEN. You reduce the mass when the thrust goes down. I think this is a highly technical question.

Mr. FULTON. The question we are asking is this: Why put it on a secondary level when we are talking about going out into space in the planetary system and when we have a danger in this country of the moon being used as a satellite?

Dr. DRYDEN. I do not think I said on the secondary. I said we are not prepared to undertake a hardware development.

In the first place, we have to get the capability of putting hundreds of tons into space before this comes in and this is going to take a few years. That was the only point.

We are continuing on a research basis. We are building a larger one and operating it under conditions in which it will operate in space, but we are not making a development contract with industry to develop an engine.

Mr. McDONOUGH. Will you yield at that point?

Mr. FULTON. Yes.

Mr. McDONOUGH. On the question of the fuel unit, cesium as against the possibility of photon energy, which of the two could you put into space in the shortest period of time beginning from now?

Dr. DRYDEN. I think the ion is much closer because the photon one takes such enormous areas of reflecting surface that the problems of being able to make this and getting it fully expanded and so on is going to be very difficult.

Mr. McDONOUGH. So the ion would be the quicker of the two?

Dr. DRYDEN. The ion is shorter in the time scale, yes.

Mr. FULTON. My request is that I would like to have some Government agency take the official responsibility for an official glossary or dictionary of scientific terms in the space field, as well as in the missile and satellite areas.

Now, we have the United States Information Agency already working on one, the United States Air Force has put one out, I understand. So I would request that your agency or in cooperation with other agencies, develop a program for an official United States glossary or dictionary, terms, phrases, or words that are referred to.

Likewise, I would like to know what the incorrect usages are and the obsolete usages and apply it to both basic and applied science on both the civilian and military fields.

I think that is broad enough. If this could be done I would like it to be done in conjunction with the American Rocket Society, your own good agency, the International Astronautical Federation, the National Science Foundation, the American Academy of Science.

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Dr. DRYDEN. We are just completing just a glossary for aeronautics that has taken us 3 or 4 years to do. So maybe you have saved this man's job.

Mr. FULTON. Also, I would like the American Research Council to be in on it. The Advisory Committee on Aeronautics ought to be in on it, also. The colleges, the companies, the research laboratories that you have been working with should be in on it.

I should say that the American Medical Society as well as the American Bar Association.

Dr. DRYDEN. The usual technique is to circulate proposed definitions to most of the agencies you have named, that is why it takes several years to do it.

Mr. FULTON. Yes, but the trouble is that we have no official United States governmental recognized dictionary or glossary of terms in the space field at this time and many agencies are working on it without proper correlation, so I think your agency should adopt the program, or some agency should take the correlation of it for everybody, maybe the United States Information Agency.

Dr. DRYDEN. I would agree that the NASA should do this job. We have done it in the aeronautics field and I think it could be done in this field.

Mr. FULTON. Now, it has been rumored officially that ARPA has 10 times more practical programs on the shelves ready to go than they have money for.

First, is that true, and second, do you recommend going further on many of these programs than has been contemplated?

To me your recommendations for money are very short of the necessities to defend this country, and to insure our security.

Dr. DRYDEN. These are the administration recommendations, sir.

Mr. FULTON. For example, the various agencies have received $500,000 for the year to study the million-pound-thrust engine.

Dr. DRYDEN. That is far too small.

Mr. FULTON. That is what I am coming up with.

How much do you think the million-pound-thrust engine will cost to develop overall?

Dr. DRYDEN. It probably would cost, depending on what stage you are thinking of, certainly hundreds of millions, perhaps of the order of $500 million.

Mr. FULTON. So at the rate of $500,000 a year for study it will take you a thousand years?

Dr. DRYDEN. So far these are only paper studies.

Mr. FULTON. What order of magnitude should we step it up to get it on a crash program?

Dr. DRYDEN. Several million dollars.

Mr. FULTON. 15 or 20 or 25 million dollars?

Dr. DRYDEN. If the total for space is $100 million, we cannot do that.

Mr. FULTON. You see, I am trying to get what we should do, not what the limiting of the ceiling is. I want to get out into space and maybe the figures will require it.

Dr. DRYDEN. I have not had access to contract estimates of what they will require to do this in the time periods.

Mr. FULTON. As part of the buildup of the program to the million-pound-thrust engine, you are probably going to take up construction of a third-of-a-million-pound-thrust engine.

Dr. DRYDEN. I don't know whether this is really necessary, or not.

Mr. FULTON. There has been testimony that that would cost in the neighborhood of $50 million as an overall program of construction.

Dr. DRYDEN. I think that is too low.

Mr. FULTON. What would your figure be?

Dr. DRYDEN. I would want to get the opinion of the contractors who are experienced in such things.

Mr. FULTON. I had asked this question of Dr. Hagen who is one of the heads of Navy research. The question was given to me as a Navy lieutenant on an examination for promotion. He was not, unfortunately, able to answer it.

Could you tell me now on the same question, suppose you have a space vehicle or missile where the thrust equaled the drag and the gravity equaled the lift. What is that vehicle or missile doing? Where is it?

Dr. DRYDEN. It sounds like a missile in the atmosphere because there is not any lift in outer space.

Mr. FULTON. Yes, but is it standing still? Is it moving?

Dr. DRYDEN. It can be moving at any speed if the lift is equal to the weight and the thrust is equal to the drag. It can be going anywhere at any speed.

Fr. FULTON. Could it not be inconstant, unaccelerated flight?

Dr. DRYDEN. Yes, horizontal flight, but the only place to do that is in the atmosphere.

Mr. FULTON. Or could it not be at the point of stall for an airplane engine that has been climbing?

Dr. DRYDEN. I do not think so.

Mr. FULTON. Thank you. You have given me a great relief because I failed that question.

That is all, Mr. Chairman.

Mr. O'BRIEN (presiding). Mr. Keating?

Mr. KEATING. Dr. Dryden, in his message mentioned instructions which he had given to the Secretary of Defense and the Chairman of NACA to reallocate space projects. Generally what do those instructions provide for?

Dr. DRYDEN. That part of it is practically one sentence, the same thing, jointly review the programs, including the lunar probes and so on that have already been approved and make recommendations to him as to which would be in Defense and which in the new agency.

The present status of this is that Defense designated Roy Johnson and Mr. Herbert York to represent the Department of Defense in the working level discussions and I have designated some people from my staff to begin discussing with them.

Then Mr. Quarles, General Doolittle, and myself, will review what the recommendation is and transmit it to the President.

Mr. KEATING. How long have you been in consultation on this?

Dr. DRYDEN. I think we have had two meetings so far.

Mr. KEATING. You have not reached any final conclusions?

Dr. DRYDEN. No final conclusions.

Some things are quite obvious. I think it has been agreed that all of this so-called use of satellites for science would come to the new agency and agreed that the reconnaissance satellites be a military project, but we have not finished at all.

Mr. KEATING. But you have reached at least some agreements to that extent?

Dr. DRYDEN. Yes.

Mr. KEATING. Do you think that the division between the military and civilian objectives is properly provided for in this bill?

Dr. DRYDEN. I think there is a division provided there, but as to any attempt to write down the words, the only way I know to work out the meaning clearly is to take specific cases and see how they come out.

Mr. KEATING. Do you think that the further progress which you and the military people may make pursuant to the President's directive might cause you to have recommendations later as to the change in the wording in this bill?

Dr. DRYDEN. It may possibly be so. I think I can illustrate the problem. We mentioned this 1-million-pound rocket. I think it is not yet clear in which category this falls.

The question is what is the military requirement for such a rocket? If there is no military requirement for a million-pound rocket, then this belongs to the space agency.

Now, military requirements are things on which I am not an expert and I suppose the opinion of the Joint Chiefs might be asked on such a problem.

Mr. KEATING. When do you anticipate you will complete your studies with the military pursuant to the President's directive?

Dr. DRYDEN. We have been instructed to be sure it is all over with by February of next year.

Mr. KEATING. In the meantime, of course, we will be reporting out a bill here.

Dr. DRYDEN. Yes.

Mr. KEATING. Has your agency, NACA, now a present plan about developing a million-pound-thrust engine?

Dr. DRYDEN. No, we do not.

Mr. KEATING. Do you have any time schedule or anything of that kind worked out?

Dr. DRYDEN. No, sir. There have been studies made under the Defense Department. If this were said to be our responsibility we would begin at that point.

Mr. KEATING. Do you have any ideas about this bill, if this bill were passed, the coordination which would take place with other agencies like the Weather Bureau, the National Science Foundation, the Atomic Energy Commission, for instance?

Dr. DRYDEN. Yes. I believe it is contemplated that the high officials of these agencies would be represented on the advisory board.

In addition to this there would undoubtedly be need for direct consultation with working level officials on very many matters. In particular, in the use of satellites for scientific research we would propose to utilize the National Science Foundation and the National Academy of Sciences in approximately the same way that they are now cooperating in the IGY programs.

Mr. KEATING. It would not be your idea that any of their present functions would be taken over into this agency?

Dr. DRYDEN. No.

Mr. KEATING. What would be the role of private enterprise as you envisage it under this new agency?

Dr. DRYDEN. Of course, the main role of private enterprise is in the hardware aspects of the business, in building things, and we would not propose to construct the devices ourselves, but to contract for their construction, to contract for the development of items of equipment and so on.

Mr. KEATING. I think that is a very significant and important statement, Dr. Dryden.

Were you given operating authority to acquire and operate and maintain laboratories and construct them and so on, it would be your idea that the construction would take place by private enterprise?

Dr. DRYDEN. This is now done with the laboratories of NACA. All have been constructed by private builders.

Mr. KEATING. That has been your practice in the past, Dr. Dryden?

Dr. DRYDEN. Yes.

Mr. KEATING. And as you envisage it in this new agency, that is the way it would operate?

Dr. DRYDEN. Yes.

Mr. KEATING. What is the weight of that tinfoil, whatever we call it?

Dr. DRYDEN. The 12-foot satellite weighs 9 pounds.

Mr. KEATING. I mean collapsed. Is it 9 pounds?

Dr. DRYDEN. Yes.

Mr. KEATING. Does it weigh the same with air in it?

Dr. DRYDEN. Yes.

Mr. KEATING. It makes no difference?

Dr. DRYDEN. It makes no difference.

Mr. KEATING. I have one other question on the makeup of this board.

As you envisage this is to be an advisory board?

Dr. DRYDEN. That is right.

Mr. KEATING. Do you not think if that is so that we would require some change in the language on page 5? I call attention to the fact that it says:

> The board shall be consulted by the director prior to—

and then there is a long number of things which is very essential to the operation of the agency and before that it says the director shall not be appointed until the board has had a reasonable opportunity to make such recommendations.

That would seem to me, by its language, to give more than a purely advisory character to the board.

Dr. DRYDEN. Let me take them up in order. The provision of 5 (b), that the board may make recommendations to the President with respect to the appointment of the director, this is the identical language I believe in the Science Foundation bill. Its objective was to get some considered review by a number of representative people of possible candidates for the position.

The President still does not have to follow their advice, but it does insure that some consideration is given by men of broad stature to this appointment.

Now, to come to section (c), it provides that the board shall be consulted by the director. It does not say that the director has to follow their advice.

Now, I have tried to explain before why I thought it was a good thing to consult the board on policies, which was to gain their support especially in dealing with groups outside the agency.

This also provides some advice on the major organizational features.

Mr. KEATING. Are you planning to be back this afternoon, Dr. Dryden?

Dr. DRYDEN. I can be, yes.

Mr. KEATING. I would like to pursue that a little further, because I think that is an important matter for us to determine here and to consider the relative advantages of this board, or a smaller commission type.

Mr. Chairman, the second bell has rung.

Mr. O'BRIEN. Yes, that occurred to me.

We do have a rather earthy problem of answering the roll call. Could you return at 2:30?

Dr. DRYDEN. Fine.

Mr. O'BRIEN. I think we can complete your questioning shortly thereafter.

So the committee will stand in recess until 2:30 this afternoon.

(Thereupon, at 12:30 p. m., the committee was recessed, to reconvene at 2:30 p. m., of the same day.)

AFTER RECESS

(The committee reconvened at 2:30 p. m., Hon. John W. McCormack (chairman) presiding.)

The CHAIRMAN. The committee wil be in order.

STATEMENT OF DR. HUGH L. DRYDEN, DIRECTOR, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, ACCOMPANIED BY PAUL DEMBLING, NACA LEGAL COUNSEL—Resumed

Dr. DRYDEN. Mr. Chairman, when I was supposedly demonstrating this ion jet, I forgot we had not turned it on for the committee. So I suggest that we have the man turn it on so that you can see the paddle wheel turn.

I think from where you sit you can see a glow of light where the light strikes the pinwheel.

Mr. McDONOUGH. What does that demonstrate?

Dr. DRYDEN. This shows there is an ion jet which is striking the pinwheel. This does give a very small fraction of an ounce thrust.

The other point I was told I did not make clear is that this folded balloon in the model of the Explorer is the same balloon as the big one simply folded up.

The CHAIRMAN. Mr. Keating?

Mr. KEATING. Dr. Dryden, I had asked you about the setup of this board. The suggestion has been made here of either (*a*) a small working commission or board composed of 5 people, with a director who might perhaps be the chairman of that board, a little bit like the Atomic Energy Commission; or (*b*) a director as here provided, with a large 17-man board.

You prefer (*b*) I take it.

Dr. DRYDEN. I prefer (*b*) because, with the larger number you get representation from the various professional groups and the Government agencies concerned. A small board of 4 or 5 could only represent a very small segment.

Furthermore, I think at least in theory there is the problem of spelling out the relative responsibilities of the other members who are full time. It is not quite as direct a line of authority; you have several people full time running the agency.

Mr. KEATING. The opposition which has been expressed to this setup has been along the line of "Here is a 17-man board meeting 4 times a year, or perhaps only 4 times a year, and they could not have the intimate supervision of the operations in a manner similar to that of a smaller group."

As I understand your position, they are not supposed to.

Dr. DRYDEN. They are not supposed to do this detail. Our present board meets nominally once a month, actually about 10 times a year. They are not dealing with the details of administration.

On the other hand, the members of the board are supposed to be people who in their normal contacts know what is going on in the space field. In other words, they are either in contact with this or in Government agencies in contact with it or perhaps they have industrial connections.

This is a matter which is not spelled out in detail. The board membership is left flexible. I would expect that the objective would be to get as many different professions and points of view, as well as representation from the Government agencies, like the AEC, National Science Foundation, Defense, and so on.

Mr. KEATING. Does it not strike you that if the director, as this is set up, were required to consult with this board prior to the initiation or substantial modification of policies or programs of the agency, it might develop into a cumbersome arrangement?

Dr. DRYDEN. If you will accept my premise that the board will meet once a month, I cannot imagine policy reversals every month. Policies, I hope, are more stable things, to be changed on some mature deliberation.

As it stands, of course, the bill spells out consultation. If the matter is sufficiently urgent, the director should proceed to act in advance of any meeting of the board.

Mr. KEATING. Perhaps we should consider making the minimum times of meeting greater than they are here. It says they shall meet at least 4 times a year. You contemplate that you should like to see them meet monthly.

Dr. DRYDEN. I would like to see this number increase somewhat as a personal view. Actually, they meet about 10 times a year at present. Perhaps some number like 6 or 8 would be more appropriate.

Mr. KEATING. Dr. Dryden, I inquired of you about the directive from the President, that is, the instructions to the Secretary of Defense and you as chairman of NACA, about the reallocation of space projects.

I take it that probably that directive itself you are not at liberty now to enter into this record?

Dr. DRYDEN. I am not at liberty at the moment to enter it into the record. I can take up the question.

On this particular point, the instruction is essentially the sentence in the President's message which instructs the Department of Defense and the NACA to jointly review the projects. There is nothing more on this point in the instructions.

The next sentence is the working out of plans of cooperation with the Defense Department.

Mr. KEATING. That is what you are working on now?

Dr. DRYDEN. We are working on both aspects.

Mr. KEATING. Is there anything else in the Presidential directive which you would feel at liberty to discuss now?

Dr. DRYDEN. I can tell you the essential content of it, I think. The first instruction is to explain the bill to Congress. NACA is given the job of explaining the bill to Congress.

Second, we are supposed to work out organization plans, what changes in the organization and management structure of NACA would be needed to fit it to undertake these new responsibilities.

I think the third one is the one of review of programs, work out a cooperative plan.

I think the final one is an instruction to Defense to submit a list of the military projects. This is the essential content of it. There is a preamble which is roughly the same as in the President's message.

Mr. KEATING. There is a time limit and that time limit is what?

Dr. DRYDEN. There is a hope or expectation that the actual transfer of those who decided to go into the new agencies will be completed by February 1959. This assumes that a law is passed by Congress, and so on.

Mr. KEATING. There are some civilian activities which the military is now conducting in connection with their space program which it is contemplated would be turned over to the new agency.

Dr. DRYDEN. That is correct. In order to avoid any delay in such activities, you may recall the President approved certain projects to be conducted by ARPA so that there would be no gap waiting for Congress to act on a new agency, but in the approval of those projects it was pointed out that there would be a reconsideration when, as and if a civilian agency was established to see whether these projects would be transferred. In fact, there is general agreement that these specific projects should be transferred.

Mr. KEATING. I think that is all, Mr. Chairman.

The CHAIRMAN. Mr. Ford?

Mr. FORD. Dr. Dryden, section 9 (a) of the bill, in effect, would give NASA what we call a no-year fund authority. Will you tell us why that language is essential for the successful prosecution of this new agency's responsibility?

Dr. DRYDEN. Well, instead of the word "essential," I would say it would enable it to operate in a more efficient manner. At the present time our construction appropriations, for example, are no-year money.

We know what money is available; we can make our plans to fit the money that is available and to push them at the best possible rate. I think the idea of this is that most space projects are going to run over a relatively long period and that this will enable a somewhat more efficient administration of funds if there is no pressure, for example, that you must get rid of all your money by a certain

date; otherwise Congress will say you do not need it and take it away from you. This enables you to plan in a more orderly manner; that is the idea.

Mr. FORD. In the Defense Department appropriation bill for the three research and development organizations they have such authority.

Dr. DRYDEN. That is right.

Mr. FORD. This would simply give to the new agency identical authority.

Dr. DRYDEN. That is correct.

Mr. FORD. Does NACA have such authority at the present time?

Dr. DRYDEN. We do not, except for construction funds.

Mr. FORD. Construction, but not for research?

Dr. DRYDEN. But not for operation; that is correct. Any money unexpended goes into the Treasury.

Mr. FORD. However, this new assigned responsibility would appear to justify a change in your research funds, putting them on a no-year rather than 1-year basis.

Dr. DRYDEN. On the same basis that the military require it for their research and development activities.

Mr. FORD. If this new agency is set up on the basis of this proposed legislation, what will the relationship be between it and ARPA?

Dr. DRYDEN. As I understand the working arrangements, and this has been discussed very briefly, there will be within the Department of Defense some projects assigned to the Air Force, space projects, or at least handed to the Air Force.

I am using this only as an example, but presumably there will be Navy projects and Army projects, and there will be ARPA projects. Just as we at present work cooperatively with the Air Force on military projects, we would work cooperatively with ARPA on the projects assigned to ARPA.

As I understand it, this is the way in which this will actually operate.

Mr. FORD. In other words, the enactment of this bill and the implementation of it would not automatically bring to an end ARPA's existence?

Dr. DRYDEN. This gets to be a legal question. I understand there is a little controversy about the legal status of ARPA. There is some language which expires next February.

There is another view that no language is necessary for the President to be able to operate in this fashion.

Mr. FORD. I did not bring the point up to determine the legality one way or the other, but ARPA, whether it is set up legally or whether it is set up administratively.

Dr. DRYDEN. They will manage the administrative projects as assigned by the Secretary of Defense.

Mr. FORD. Would NASA have legal authority to make contractual arrangements with the various service research and development agencies, Army, Navy, and Air Force?

Dr. DRYDEN. Yes, sir; there is very broad authority. That is on page 8,

to use, with their consent, service, equipment, personnel and facilities, Federal and other agencies, with or without reimbursement, and on a similar basis to cooperate with other public and private agencies and instrumentalities in the use of service, equipment and facilities of the agency.

Then there is authority to transfer without reimbursement such things as technical supplies. There is authority to enter into cooperative agreements under which members of the Army, Navy, Air Force, and Marine Corps may be detailed by the appropriate Secretary for service in the performance of functions under this act to the same extent they might be assigned to the defense.

As I read this, this provides for broad authority to enter into any type of agreement, contract or whatever the particular nature of the agency that we want to use requires.

I hope that this broad authority stays in because I think it will then enable the agency to utilize the people who are now doing the work, whether they are in private industry, whether in military departments, or wherever they may be, and under conditions that can be worked out in each specific case.

Mr. FORD. You mentioned in response to a question by Mr. Keating that your current advisory board meets on an average of 10 times yearly.

Dr. DRYDEN. Yes.

Mr. FORD. For how many days do they meet?

Dr. DRYDEN. It is usually an afternoon meeting. They function very much like a board of directors of a company, concerning themselves with very broad questions and not with detailed administrative questions.

Mr. FORD. Do they give adequate time on that kind of schedule to pass judgment on the broad aspects of a program?

Dr. DRYDEN. I think so. They do receive, of course, from the various technical advisory committees, recommendations which they consider. Perhaps I might illustrate it by the way the budget process begins in NACA now.

The board fixes the general policy; they decide, "Are we to increase effort 25 percent; are we to stay level? What are the broad policy decisions to be made about the budget?"

The staff then works up the details on how many men it takes to do this, what the dollars are, and what are the supporting supplies. When that task is finished, it usually comes back to the board in summary form to see what the result of the staff work has been and there is an approval or disapproval at that point under the present arrangement.

Under the new arrangement the provision is that the board would be consulted but they would not have to approve it. In fact, the budget could be submitted in advance of submitting it to the board.

I beg your pardon. I must correct that. I believe the language says "consult prior to submitting the budget." This is usually not a problem because, as you know, the usual budget date is in September. This means at a June or July meeting we get some policies determined and the staff goes to work on the documents which are to go before the Budget Bureau.

Mr. FORD. For how many years has your current advisory board setup worked as you described it a minute ago?

Dr. DRYDEN. Forty-three years; since 1915.

Mr. FORD. NACA has had a very successful record over that period of time, using that procedure.

Dr. DRYDEN. Using this procedure. I know that some people say it cannot possibly work, but the fact is that it has worked extremely well.

The CHAIRMAN. Mr. Fulton, did you want to ask some questions?

Mr. FULTON. Yes. Should there be a provision in the legislation that when there gets to be a question whether certain facilities or equipment should be turned over by various agencies to the new space agency, that the President shall have the right to make that determination?

Dr. DRYDEN. That is in the law, perhaps not spelled quite in the language you have said.

For a period of 3 years after the effective date of this act, the agency, with the concurrence of the head of the department or agency concerned and with the approval of the President, may transfer to itself any functions (including powers, duties, activities, facilities, and parts of functions) of such department or agency or of any officer or organizational entity thereof which relate primarily to the functions of the agency as set forth in section 6 hereof. In connection with any such transfer the President may, under authority of this section or under other applicable authority, provide for appropriate transfers of records, property, civilian personnel, and funds.

The CHAIRMAN. That is a double negative, though, with the President in the second negative. In other words, it must start with the new agency; second it must be with the concurrence of the head of the department or agency, which means that the head of the department or agency has the veto; and third, with the approval of the President.

Dr. DRYDEN. Yes, sir.

Both the head of the agency and the director would be responsible to the President. I do not see anything which prevents the director of the agency taking that problem to the President if he cannot come to an agreement with the head of the agency.

The CHAIRMAN. Can you mention to this committee any precedent anywhere else for that, that kind of language?

Dr. DRYDEN. I do not know. This is a temporary thing for 3 years. It is part of the transition process. It does not go on indefinitely.

Mr. FULTON. There is the use of the word "may," which is permissive. It might be made mandatory with the word "shall."

Secondly, as the "President shall provide" might be turned into how the President might order, giving him the power to order and not a word like "provide." I agree with Mr. McCormack that it seems to leave it to the agencies.

Dr. DRYDEN. I think the President has the power and I think this language provides it. Of course, again I am not a professional lawyer.

The CHAIRMAN. Suppose Congress agrees to the transfer of some other activity like the National Science Foundation to the new agency; Congress would then have an opportunity of passing upon it which it would under any reorganization plan?

Dr. DRYDEN. I think it would apply only to those functions which pertain to space, as I read this. Now certainly Congress is free at any time to take legislative action affecting the organizational structure.

Let us get very specific. Let us take Dr. Hagen's group, which is now a naval activity. As I read this legislation as a whole, not just

this section, there are three possibilities for incorporating that activity into the new agency.

One is to leave it where it is and transfer funds to support it. The second is to transfer it into the new agency and leave it where it is and rent from the Navy whatever is necessary. The third possibility is the transfer of the agency out completely and move it somewhere else.

As I read the law, any of those three solutions could be done and it will be done with the approval not of the Secretary of the Navy, but of the Secretary of Defense, as I read this——

Mr. FULTON. Do you not feel, though, when it comes to the magnitude that Mr. McCormack has pointed out, on the agency or installation level, that when a whole fabric of productive facilities, plus personnel, is turned over, that there should be some specific method of doing it, possibly with the approval of Congress or with the reorganization plan submitted within a certain number of days?

Dr. DRYDEN. I, as an individual, certainly would have no objection to this. This is an attempt to deal with a transition situation while the new agency is being organized.

The CHAIRMAN. Any further questions?

Mr. FULTON. Would you submit a statement for the record giving the policy of your agency in the handling of patents, copyrights, chemical formulas and chemical processes?

Secondly, I would like to ask, too, the policy on handling security policies, just a general statement.

Dr. DRYDEN. Just a general statement. We, of course, have regulations which are pretty consistent with those of Defense and AEC. It is quite a collection.

(The material referred to is as follows:)

RULES AND REGULATIONS RELATING TO PATENTABLE INVENTIONS OF EMPLOYEES OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Attachments:

(1) Administrative Order No. 5 of the Government Patents Board approved 26 April 1951 (16 F. R. 3927).

(2) Form NAVEXOS-2374 (Rev. 4-51), Record of Invention and Instructions for Preparation thereof.

(3) Form NAVEXOS-2375 (Rev. 1-47), Disclosure of Invention.

1. *Executive Order 10096.*—By Executive Order 10096 dated 23 January 1950 (15 F. R. 389), the President established a basic Government patent policy with respect to the inventions made by employees of the Federal Government under which the Government may, under certain conditions, acquire title to inventions made by its employees, while providing for partial or complete retention of rights by employees under other conditions. Determination by a Government agency that the Government has or is to take less than full title to an invention is subject to approval by the chairman of the Government Patents Board established under this order.

2. With a view to obtaining uniform application of the policy set out in this order and uniform organization thereunder, the chairman of the Government Patents Board is authorized and directed, after consultation with the board, to formulate and submit to the President for approval such proposed rules and regulations as may be necessary or desirable to implement and effectuate the policies established. Each Government agency is also required to take all steps appropriate to effectuate the order, including the promulgation of necessary regulations which shall not be inconsistent with those approved by the President.

3 *Government Patents Board Implementing Rules and Regulations.*—On 26 April 1951 the President approved certain rules and regulations under Executive Order 10096 which have been issued as Administrative Order No. 5 of the

Government Patents Board (16 F. R. 3927), attachment (1). These rules and regulations in section 6, thereof, restate the basic Government patent policy established by the President; and in this section and certain others set forth the responsibilities of government agencies. The agency responsibilities, among others, include determination of invention, determination of rights in inventions, determination of whether patent protection will be sought in the United States, and the furnishing of certain reports.

4. *NACA Responsibilities.*—In carrying out these agency responsibilities for the Natioanl Advisory Committee for Aeronautics, NACA headquarters will be responsible for and, with the assistance of patent counsel made available by the Department of the Navy or other appropirate agency, will discharge the following functions:

(a) Determine whether the results of research, development, or other activity within the National Advisory Committee for Aeronautics constitute invention within the purview of Executive Order 10096;

(b) Determine, subject to review by the chairman of the Government Patents Board, the respective rights of the Government and of the inventor in and to any invention made by an employee of the National Advisory Committee for Aeronautics;

(c) Determine, subject to certain exceptions noted hereinafter, whether patent protection will be sought in the United States by the National Advisory Committee for Aeronautics for usch inventions, and;

(d) Furnish reports as required to the chairman of the Government Patents Board relating to the determination of rights, the taking of appeals, the filing of applications, and the issuance of patents.

DETERMINATION AND ASSERTION OF RIGHTS

5. *Conditions for Assignment.*—The National Advisory Committee for Aeronautics may require assignment of title to inventions made by its employees and to patents that may be issued on such inventions if any of the following conditions are present:

(a) If the invention was made during working hours; or

(b) If the invention was made with a contribution by the Government of facilities, equipment, materials, funds, or information, or of the time or services of other government employees on official duty; or

(c) If the invention bears a direct relation to or was made in consequence of the official duties of the inventor.

6. *Definitions of Conditions.*—In determining whether a condition set forth above was present in the making of the invention, the following definitions shall apply:

(a) Working hours shall mean time spent during either the usual working hours, overtime, or both;

(b) A contribution of facilities shall mean that the facilities were used in the making of the invention and while so used were made unavailable for other purposes;

(c) A contribution of equipment shall mean that the equipment was used in the making of the invention and was thus made unavailable for other purposes;

(d) A contribution of materials shall mean that the materials were specifically obtained and used for the purpose of making the invention and were thus rendered unavailable for other use;

(e) A contribution of funds shall mean that government funds were actually expended for the purpose of making the invention;

(f) A contribution of information shall mean that the information used in the making of the invention was available only by reason of the inventor's official duties and was obtained from sources not otherwise available;

(g) A contribution of time or services of other Government employees on official duty shall mean that their time or services were utilized during working hours as defined in (a) above;

(h) Bearing a direct relation to or made in consequence of the official duties of the inventor means that the duties to which the inventor had been assigned were such that the invention could reasonably be expected to arise therefrom.

7. *When Assignment is Required.*—When any of the conditions set forth in paragraph 5, as defined in paragraph 6, are present, the domestic rights and, in

the discretion of NACA headquarters, foreign rights in and to the invention shall belong to the Government if

(a) The conditions are equitably sufficient to justify assignment thereof by tht employee to the Government; and

(b) The Government has sufficient interest in the invention to require assignment thereof by the employee.

If it should be found that assignment is not required under (a) and (b) of this paragraph, the employee nevertheless shall be required to grant to the Government a nonexclusive, irrevocable, royalty-free license in the invention and under any patents which may issue thereon, with power to grant licenses for all governmental purposes. When none of the conditions set forth in paragraph 5, as defined in paragraph 6, are present, the entire right, title, and interest in and to the invention shall be left in the employee, subject to law.

8. *When Conditions Are Presumed.*—It is presumed that the conditions of paragraph 5, as defined in paragraph 6, are present, when the employee is employed or assigned:

(a) To invent or improve or perfect any art, machine, manufacture, design, or composition of matter;

(b) To conduct or perform research or development work, or both;

(c) To supervise, direct, coordinate, or review government financed or conducted research work, or both; or

(d) To act in a liaison capacity among governmental or nongovernmental agencies or individuals engaged in such research or development work, or both.

9. *Burden of Proof.*—Employees within the classes defined in paragraph 8 may submit evidence that will enable NACA headquarters to establish the absence of any one or more of the conditions of paragraph 5, as defined in paragraph 6, or that the conditions which are present are insufficient equitably to justify a requirement that assignment be made to the Government of the invention and any patent which may issue thereon. For employees not within the classes defined in paragraph 8, the Government must establish that the conditions of paragraph 5, as defined in paragraph 6, if present, are sufficient equitably to require an assignment to the Government of the invention and to any patent which may issue thereon.

10. *Foreign Rights*—An assignment of the foreign rights in and to the invention shall be made by the employee, upon request, whenever an assignment of the domestic rights is required. Where, however, an assignment of the domestic rights is not required, an assignment of the foreign rights in and to the invention may be made by the employee, upon request.

APPEALS AND PETITIONS

11. *Appeals.*—Any employee of the National Advisory Committee for Aeronautics who is aggrieved by a determination by NACA headquarters pursuant to paragraph 7 may obtain a review of the determination by filing, within thirty (30) days (or such longer period as the chairman of the Government Patents Board may, for good cause, fix in any case), after receiving notice of such determination, a written appeal with the chairman of the Government Patents Board and a copy of the appeal with NACA headquarters.

12. In the event of the filing of an appeal, NACA headquarters, subject to conditions of national security, shall furnish the chairman of the Board in writing, promptly upon the filing of the appeal, the information required by paragraph 7 (b) of attachment (1). The decision of the chairman of the Board upon any appeal taken pursuant to paragraph 11 shall be final.

13. *Petitions.*—In the event that NACA headquarters determines pursuant to paragraph 7 that the domestic rights in and to an invention will be left with an employee with or without a license in favor of the Government, a report of this determination is required to be submitted to the chairman of the Board for review, subject to the right of the employee, if he acquiesces in the determination, to file a petition in the event of a decision less favorable to him.

14. The chairman of the Board will review such a determination by NACA headquarters, and his decision respecting the matter shall be final, subject to the right of the employee to submit to the chairman, within thirty (30) days, (or such longer period as the chairman may, for good cause, fix in any case),

after receiving notice of such a decision, a petition for the reconsideration of the decision if it gives to the Government greater rights than the determination made by NACA headquarters A copy of any such petition must also be filed by the employee with NACA headquarters within the prescribed period.

PATENT PROTECTION

15. *General.*—NACA headquarters, upon determining that an invention has been made under the conditions specified in paragraph 5, as defined in paragraph 6, shall thereupon determine whether patent protection will be sought in the United States by the National Advisory Committee for Aeronautics for such invention. A controversy over the respective rights of the Government and of the employee in any case shall not delay the taking of any action seeking such patent protection. In cases pursuant to paragraph 7 where it is determined that the domestic rights in and to the invention are to be left with the employee, action by the National Advisory Committee for Aeronautics looking toward such patent protection shall be contingent upon the consent of the inventor.

16. *Dispute as to Rights*—Where there is a dispute as to whether the Government is to obtain an assignment of the domestic rights in and to the invention or only a license thereunder, NACA headquarters will determine whether patent protection will be sought in the United States pending the decision of the chairman of the Government Patents Board on the dispute, and, if NACA headquarters decides that an application for patent should be filed, will take such license rights as are specified in subparagraph 6 (b) (2) of attachment (1), but this shall be without prejudice to acquiring an assignment of the domestic rights in and to the invention as specified in subparagraph 6 (b) (1) of attachment (1) should the chairman of the Board so decide.

17. *Rights in the Employee*—Where, however, NACA headquarters has determined to leave the domestic rights in and to the invention with an employee subject to a license in favor of the Government and the employee acquiesces in this determination, NACA headquarters will, upon the filing of an application for patent and pending review of the determination by the chairman of the Government Patents Board, take such license rights as are specified in subparagraph 6 (b) (2) of attachment (1), without prejudice to the subsequent acquisition by the Government of the domestic rights in and to the invention as specified in subparagraph 6 (b) (1) of attachment (1), should the chairman of the Board so decide.

REPORTING OF INVENTIONS

18. *Employee Defined.*—The term "employee" as used herein means any officer or employee of the National Advisory Committee for Aeronautics, including any part-time consultant or part-time employee except when special circumstances in a specific case require a departure herefrom to meet the needs of the National Advisory Committee for Aeronautics. Such circumstances shall be reported to the chairman of the Government Patents Board and separately promulgated if approved by him.

19. *Responsibility of Employee*—

(a) Whenever an employee of the National Advisory Committee for Aeronautics conceives an idea which he believes to be of a patentable nature he shall prepare a memorandum describing in detail such idea and the means which he proposes for its reduction to practice, and shall submit it through official channels to NACA headquarters together with a formal Record of Invention and Disclosure of Invention on Forms NAVEXOS 2374 and 2375, respectively, or such other forms as may hereafter be prescribed. The memorandum shall include a statement describing the circumstances under which the invention was made, with particular regard to the conditions listed and defined in paragraphs 5 and 6, respectively, of these regulations.

(b) If a decision is reached to proceed with the procurement of a patent, the employee shall cooperate fully with patent counsel in the preparation of a patent application of such scope as will assure maximum protection of the Government's interests, and, subsequently, as may be required from time to time during the prosecution of the application, in the preparation of amendments responsive to Patent Office actions thereon

20. *Responsibility of Laboratory.*—

(a) The reporting of patentable inventions resulting from the research activities of the National Advisory Committee for Aeronautics is the joint responsibility of the supervisory personnel and the individual employee who conceives the idea upon which the invention is based. A disclosure made by an employee shall be amplified, if possible, by the comments of his supervisors, and shall be transmitted through official channels to NACA headquarters with full information concerning the inventor's employment status and work assignment at the time the invention was made, and with definite recommendations regarding the initiation of patent action, and the respective rights to be claimed for the Government and for the employee.

(b) To avoid jeopardizing the interests of the Government, the laboratory shall promptly notify NACA headquarters of any public disclosure, by publication or otherwise, of any patentable developments of its employees not already protected by United States patent or patent applications.

DETERMINATION OF INVENTION

21. *Invention Defined.*—The term "invention" as used herein means any art, machine, manufacture, design, or composition of matter or any new and useful improvement thereof, or any variety of plant, which is or may be patentable under the patent laws of the United States.

22. *When and by Whom Determined.*—NACA headquarters, with the assistance of patent counsel made available by the Department of the Navy or other appropriate agency, will be responsible for determining whether the results of research, development, or other activity within the National Advisory Committee for Aeronautics constitute invention, and where practicable, will make this determination before determining the respective rights of the Government and the employee on the basis of information furnished by the employee and the laboratory, together with such other information as may be required.

SCOPE OF REGULATIONS

23. *Inventions Covered.*—The foregoing provisions of these regulations apply to any invention made by an employee on or after 23 January 1950 and to any action taken with respect thereto, and with regard to such invention supersede the patent policy of the National Advisory Committee for Aeronautics dated 30 June 1949. As to inventions made before 23 January 1950, the respective rights of the Government and the employee will be determined under the provisions of the patent policy of the National Advisory Committee for Aeronautics approved 20 October 1944, as amended 30 June 1949.

HUGH L. DRYDEN, *Director.*

OCTOBER 1, 1951

SECURITY CLASSIFICATION

It is the policy of the NACA to classify research information if, and only if, the publication of the information would assist a potential enemy more than it would assist the United States. NACA's policy has been maximum disclosure of information consistent with national security. Much of NACA research relates to military weapons or has potential military utilization, in which case we are guided by the policies of the military services in assigning security classification.

The results of NACA classified research are made available to the interested Government agencies and military services and to appropriate Government contractors, such as manufacturers of missiles or aircraft cleared for handling classified information.

Mr. FULTON. Then I would like a listing of the matters which are now in dispute over jurisdiction with ARPA as to projects.

Dr. DRYDEN. I am unable to do that, because the negotiations have not gotten that far. In fact, ARPA does not have a specific program at this time to do it that way.

Mr. FULTON. Can you give us the current statement of the standing of negotiations with ARPA so that we can see who is doing it and how it is being done?

Dr. DRYDEN. Yes.

(The material referred to is on p. 949.)

Mr. FULTON. I also would like to have a calendar put into the record at this point of your agency's participation in the IGY and also the future calendar of how you are going to finish it; in short, by date, just a summary.

Dr. DRYDEN. We have only incidental contact at the moment with IGY.

Mr. FULTON. Yes; but I would like it summarized so that someone can look down and see by date the calendar of your activities.

Lastly, I would like to know what your relation has been, for example, with the International Civil Aviation Organization, the ICAO, under the United Nations. And, lastly, the relations that your agency may have had with Russian and satellite scientists.

Dr. DRYDEN. None whatever; I can answer that right now.

(Material referred to is as follows:)

RÉSUMÉ OF NACA SPACE RESEARCH CONTRIBUTING TO THE UNITED STATES INTERNATIONAL GEOPHYSICAL YEAR PROGRAM

The extensive and sustained effort over many years of the National Advisory Committee for Aeronautics (NACA) in pressing forward scientific knowledge of the earth's atmosphere and of flight at ever increasing altitudes into space, thereby making possible and supporting the upper atmosphere sounding rocket and the earth satellite projects of the United States International Geophysical Year program, are briefly traced as follows.

1922: NACA assembled and analyzed the existing information on the earth's atmosphere, formulating and compiling it into the standard atmosphere, and published as NACA Report No. 147.

1925: NACA extensively enlarged the standard atmosphere, publishing it as NACA Report No. 218.

1946: NACA formed the special Committee on the Upper Atmosphere, drawing together the Nation's most qualified scientists to assemble, summarize, and compile knowledge of the earth's atmosphere out to the borders of space. The results were published as NACA Technical Note 1200 and formed the foundation for the exploration of the upper atmosphere by means of sounding rockets.

After World War II, NACA has continuously furnished a technical consultant to, and rendered assistance to, the V–2 Panel, later known as The Upper Atmosphere Rocket Research Panel, and now called The Rocket and Satellite Panel, of which Dr. James A. Van Allen is the present chairman. Under this panel was coordinated the upper atmospheric research done prior to the International Geophysical Year using the V–2, and later the Aerobee and Viking rockets whose designs are based largely on numerous NACA technical reports. The development of the high-performance, solid-propellant Deacon rocket, as reported in NACA Research Memorandum L8H26, made possible the inexpensive combination rocket and balloon system, called Rockoon, used by Dr. Van Allen for cosmic ray research.

1952: NACA played a major role in developing and promulgating the first internationally adopted "Standard Atmosphere," bringing order in this field for the first time on a worldwide basis. NACA was entrusted with the compilation of this internationally used standard atmosphere in both metric and English units, and published it as NACA Report 1235.

1955: In preparation for the United States rocket and satellite programs for the International Geophysical Year, NACA furnished two members to the main

committee convened to draw up the Air Research and Development Command model atmosphere 1956, which is a preliminary extension to extreme altitudes of the International Standard Atmosphere of NACA Report 1235, that is used as a guide during the International Geophysical Year. The NACA furnished a member of the 12-man special committee appointed to formulate the detail specifications of this extension, and furnished the member who served as chairman of the Special Committee on Physical Constants.

With the organization of the United States National Committee for the International Geophysical Year, the NACA furnished two members—Dr. Hugh L. Dryden, as a member of the United States National Committee, and Mr. William J. O'Sullivan, as a member of the Technical Panel on Rocketry and as the experimenter responsible for two of the officially approved and scheduled satellite experiments furnished by NACA.

In support of the United States IGY program exploring the upper atmosphere, NACA, through its member on the Technical Panel on Rocketry, proposed both the Nike-Deacon (or Dan) and the Nike-Cajun (or Can), solid-propellent sounding rockets. These simple and relatively inexpensive vehicles made possible a great increase in the number of sounding rockets the United States is launching during the IGY without increase in cost, as well as making possible tests not capable of being performed by other rockets The NACA designed, constructed, and tested in flight these two sounding rockets, as reported in NACA Technical Note 3739 and NACA Research Memorandum L57D26 In addition, during NACA flight tests of these sounding rockets, instrumentation to be used during the IGY was tested and rocket-launching crews for the IGY were trained by NACA. The high-performance Cajun rocket motor of one of these sounding rockets was developed by NACA and made available for use in the IGY program. Five different agencies of the United States and their contractors are using the Nike-Deacon and the Nike-Cajun sounding rockets in the IGY program.

In support of the United States IGY program on artificial earth satellites, the NACA has invented, designed, and developed the compactly foldable and pneumatically erectable NACA 30-inch diameter subsatellite for use on the Vanguard launching system, and the NACA 12-foot-diameter satellite for use on the Explorer launched by the Jupiter-C launching system. The smaller subsatellite was proposed to the Technical Panel on the Earth Satellite Project of the United States National Committee for the International Geophysical Year on January 26, 1956, and the larger satellite on December 3, 1956 Both have been officially approved by the panel and are essentially ready for use. These are by far the largest earth satellites in the United States IGY satellite program. These two NACA-contributed satellites are the only known means whereby the density of the earth's atmosphere at the borders of space can be accurately measured, so that there may be known the altitude at which satellites of the future must orbit in order to remain in orbit the desired length of time

All of the foregoing research, including that in support of the United States International Geophysical Year program, has been performed entirely by the NACA with its own funds.

Mr. FULTON. Has not a scientist from behind the Iron Curtain had access to certain installations?

Dr. DRYDEN. No; they have not.

Mr. FULTON. Was it not on August 25 last year that they came to some installations in the United States on the missile program?

Dr. DRYDEN. They may have. They did not come to any installations of NACA.

Mr. FULTON. So that you can say firmly or categorically there has been no person of a foreign birth from behind the Iron Curtain that has had access to your facility, personnel, or consultations?

Dr. DRYDEN. What do you mean by "access to personnel"?

Mr. FULTON. I mean on your facility.

Dr. DRYDEN. No; there have been no visitors from behind the Iron Curtain to any NACA facility.

Mr. FULTON. My questions have been firm, but do you think they have been fair?

Dr. DRYDEN. Absolutely.

Mr. FULTON. And I hope completely nonpolitical.

Dr. DRYDEN. Yes.

The CHAIRMAN. Mr. O'Brien?

Mr. O'BRIEN. Mr. Chairman, I would like to continue briefly, if I may, on the urgency and continuing importance of what we are trying to do here, and what the President is recommending. I know that Congress feels it is important or you would not be here today before a new committee. I note from what the President has said that he regards this as a very urgent matter and a matter of continuing importance.

Nevertheless, it has been suggested in some places that because we and the Russians have shot some satellites up in the sky that we were overcome by a sort of science-fiction fever, and that when all this levels out and we get over the excitement, that this whole problem will not be as important as we now consider.

I would like to ask you this question: Do you believe in the long-range scheme of things that what we do in this field, whether the Director is of Cabinet rank or not, is just as important as, if not more important than, the legislation creating the Atomic Energy Commission?

Dr. DRYDEN. I think, looking at the future, this is quite true. The difference is that I do not think we can spell out so clearly the character of the military weapons systems as we could at the time AEC was set up, in the long run.

Mr. O'BRIEN. You think that this problem is of such importance that we are not going overboard, for example, in suggesting the possibility that this agency have Cabinet rank, or rank very close thereto?

Dr. DRYDEN. I think I answered that earlier. The question is merely: Shall you do it at the start or shall you wait and see whether this actually does grow to the size that you are thinking about?

Mr. O'BRIEN. Thank you very much.

The CHAIRMAN. You seem to be rather fixed on the organizational setup provided for in the bill, with a single director. Would you apply that to all other commissions?

Dr. DRYDEN. I think if you want clear-cut authority from some one person who is responsible, that is a pretty good model.

The CHAIRMAN. Do you give recognition to the fact that the individual might be mistaken?

Dr. DRYDEN. This, I think, is one of the chief virtues of this Advisory Board, who continually has it in view, compared to the difficulty of those who do not have some of the views of the Agency.

The CHAIRMAN. So you consider that the Advisory Board will check on the individual?

Dr. DRYDEN. In a way. As I expressed it before, this makes the Director and the Agency act in the goldfish bowl of complete knowl-

edge, have access to any information relating to the operations of the Agency from people who are not full time identified with it, who are acquainted with the broad aspects of this space business, and who know what people on the outside think.

I think this is one protection that such an advisory board gives to the Congress and to the administration.

The CHAIRMAN. In other words, you rely on the functions of the Advisory Board to fill in the gap where an individual might make mistakes.

Dr. DRYDEN. I would think it is very parallel to the board of directors of a company. If the board of directors does not like the way the company is operated, they will try to get a new president. I would presume this Board would do the same thing.

The CHAIRMAN. You proceed on the theory of the structure of the Board and the Congress serving the people.

Dr. DRYDEN. Essentially not in all complete details, but the idea of a group of people who are continually examining what is going on and who are in a position to bring this to the attention of someone outside the Agency.

The CHAIRMAN. Why would not a commission of 3 or 5 be more effective?

Dr. DRYDEN. If they are full time, they are full time employees of the Agency. They are on the receiving end of the inspection. You have to have somebody, then, a committee of Congress or someone who is continually monitoring.

The CHAIRMAN. I know, but every agency appoints an advisory board. There is nothing new about that. On this, one is provided for by statute. You have several hundred persons on different committees.

Dr. DRYDEN. There is a General Advisory Committee to the AEC provided by the statute.

The CHAIRMAN. Will you repeat that?

Dr. DRYDEN. The General Advisory Committee to the Atomic Energy Commission is provided by statute. The National Science Foundation Board is provided by statute. I think there are a considerable number.

The CHAIRMAN. The AEC, of course, has a Commission of five men.

Dr. DRYDEN. Yes; but they have a General Advisory Committee also, by law.

The CHAIRMAN. But they have a Commission by law.

Dr. DRYDEN. Yes.

The CHAIRMAN. How much consultation did you have with Mr. Finan or your counsel or anybody representing you in connection with the drafting of this bill?

Dr. DRYDEN. I personally had discussions with him about 3 or 4 times. Paul, you sat in continuously, I think.

Mr. DEMBLING. Primarily the consultations I had with Mr. Finan and his staff were in terms of the functions of the Agency and the authorities that would be needed by the Agency to carry out the functions of that Agency as provided in the legislation.

The CHAIRMAN. Now you say the Board is advisory, but the language of the bill gives some powers beyond advisory; does it not?

Dr. DRYDEN. I do not read it that way.

The CHAIRMAN. Well, shall be consulted by you for basic propositions.

Dr. DRYDEN. This says you must discuss the budget with them, but it does not say that you have to follow their advice. That is why I call it advisory.

The CHAIRMAN. That is true, but when you appoint an advisory committee in accordance with general provisions of law, where you have the authority to do that, do you recognize that there might be a difference in the advisory committee than where it is definitely established by law?

Dr. DRYDEN. I do not understand the question.

The CHAIRMAN. Here is a Board specifically provided for by law and—

shall be consulted by the Director prior to (1) the initiation or substantial modification of policies or programs of the Agency.

Dr. DRYDEN. That is right.

The CHAIRMAN. If you are a member of the Advisory Board appointed by the President, would you not think that your views would be pretty well followed by the Director?

Dr. DRYDEN. If the Board is unanimous, I think the Director would want to be sure of his ground in doing differently, but I think in this case the matter would go to the President.

The CHAIRMAN. We are all conversant with human nature, you know. I am reading in here the human mind, human nature.

If I am a member of a board appointed by specific provisions of the law, and appointed by the President, I would consider that my power would be rather broader than if I were put in as a member of the advisory group by the head of an agency or by a commission.

Dr. DRYDEN. I would agree with that.

The CHAIRMAN. So that you can read into this that this Board will have more authority in its own mind than would be the case if it were not provided specifically for by law and appointed in accordance with the administration.

Dr. DRYDEN. They will be an influential Board.

The CHAIRMAN. Now, in the case of a weak director, it could be very harmful.

Dr. DRYDEN. This, I think, assumes that the President will appoint a weak director and a strong Board.

The CHAIRMAN. No. I am not assuming that at all. Those things do happen, of course.

Dr. DRYDEN. Well, if the director is weak he should be removed.

The CHAIRMAN. That is easily said, but sometimes hard to do. Of course, we are not wedded to this language. You would not mind if the language says the Board may be consulted by the Director, would you?

Dr. DRYDEN. I personally would have no objection.

The CHAIRMAN. And you would not object to changing the language giving complete respect to the orders of the President in connection with any transfer which takes place under section 8?

Dr. DRYDEN. Not at all; I would have no objection.

The CHAIRMAN. Those are details.

Dr. DRYDEN. Yes.

The CHAIRMAN. You would have no objection to provisions being put into the bill providing for, say, a liaison between any new agency and the Defense Department?

Dr. DRYDEN. I personally have none.

The CHAIRMAN. And with the AEC? Those are the two real agencies where matters of great importance probably would develop.

Dr. DRYDEN. I think it would be more economical to do it on one liaison group than on the large numbers.

The CHAIRMAN. Liaison for both?

Dr. DRYDEN. Yes.

The CHAIRMAN. That is a matter for consideration. But some operating group meeting frequently or constantly——

Dr. DRYDEN. You see, I come back again. In my own opinion the Board as there proposed, with membership from AEC, from Defense, National Science Foundation, and other agencies concerned, is an effective way of accomplishing what you are proposing to do, or at least discussing, separate liaison committees for each agency.

If you have one with AEC and one with Defense and another one with Science Foundtion on their problems, there are many Government agencies in which there should be liaison. My understanding is that is what the draft of the bill proposes to do by having eight Government representatives on the Advisory Board.

The CHAIRMAN. Assuming the enactment of a law establishing—well, you would not feel offended if you were called an administrator, would you?

Dr. DRYDEN. No. That is all I do.

The CHAIRMAN. I know, but there is a difference in interpretation between being called a director and administrator in Government circles. Being called an administrator would indicate a high level of thought on the part of the Congress, and responsibility, and so forth.

You would have no objection to a joint legislative committee somewhat like the AEC performing similar functions?

Dr. DRYDEN. I assume that Congress will write into this bill whatever the congressional organization is that is decided on for space. I should think you would do that.

The CHAIRMAN. Now, it has been indicated to me, without mentioning the source of the indication, that there were some who feel that with the enactment of this bill, this agency would be only a matter of passing attention.

If we enact it into law and you are appointed director of this agency, or administrator, or whatever the committee might in its wisdom make the title, do you consider that this new agency, projecting your mind into the future—that means the immediate and the foreseeable

future—that this agency is necessary in the national interest of our country?

Dr. DRYDEN. I think so.

The CHAIRMAN. As such, you as the bureau director or administrator would do everything to see that the importance of the agency is advanced at all levels from the President on down?

Dr. DRYDEN. Yes. I have no commitment that I will be the director. I wish to make it clear for the record.

The CHAIRMAN. I know that; I understand that and I appreciate your modesty. I am trying to get your thoughts for the record.

Are there any further questions? Mr. Feldman?

Mr. FELDMAN. Dr. Dryden, I believe in answer to a question put to you by Congressman Ford, you stated that the advisory board as presently constituted operated in the nature of a board of directors.

Dr. DRYDEN. That is correct.

Mr. FELDMAN. I can see where you can reach that conclusion because the director is responsible to the board for his actions.

Dr. DRYDEN. That is correct. I am sorry if I was not clear on this point. The present board corresponds much more exactly to the function of a board of directors of a company.

Mr. FELDMAN. Yes. That was the question put to you by Congressman Ford. I do not think it was a question; rather it came out of a response to a question he asked.

Now, the present proposal which is before this committee changes that and makes the board advisory in function only; is that right?

Dr. DRYDEN. That is right.

Mr. FELDMAN. And the President is over the board, and so on. In that respect, then, it differs from the traditional way in which a board of directors operates; is that right?

Dr. DRYDEN. It does not have the power of the board of directors. It will deal with the same matters, as I see it; the same kind of matters as a board of directors, but instead of controlling, it will be advisory.

Mr. FELDMAN. In a company, for example, that has a board of directors, the board of directors can fire the president.

Dr. DRYDEN. That is right.

Mr. FELDMAN. What they are interested in is the bottom line, the performance of the company.

Dr. DRYDEN. That is right.

Mr. FELDMAN. Now, in response to a question asked you by Congressman Sisk earlier today, you characterized the new setup, at least the board, as in the nature of group of kibitzers. I am quoting you now.

Dr. DRYDEN. I was trying to illustrate that they perform a function of observing, commenting on, criticizing, and recommending to others with respect to the operations of the agency.

If the director and board work together, the board becomes a strong support for the director.

Mr. FELDMAN. In response to a question by Congressman McCormack, you stated there was no need for a specific liaison committee, because in effect the members of the advisory board were, in fact, acting as liaison because they came from different branches of the

service or the different branches of the Government that were interested in various phases of this program.

I do not see how you can reconcile that liaison activity with one of being kibitzers, and the liaison should have a defined function in order to perform efficiently. Do you not agree on that?

Dr. DRYDEN. There are two kinds of liaison. One is that of broad policy, broad issues. The other is the everyday working liaison in which at present we have military people in our laboratories.

They deal directly with the working level on the cooperative projects. That is a technical liaison.

Mr. FELDMAN. That kind of liaison is one thing. No liaison of the kind contemplated, such as the one existing between the Atomic Energy Commission and the military, is interfered with by the other type of liaison that you are speaking of.

Dr. DRYDEN. That is right.

Mr. FELDMAN. That exists between the AEC and the various branches of the military in the lower levels; is that right?

Dr. DRYDEN. That is correct.

Mr. FELDMAN. This is in addition to that, so the functions are different and they do act accordingly.

Dr. DRYDEN. I think the functions you talk about must be performed. We operate a good bit in an informal manner with the military services, and the AEC now. We go see Admiral Strauss and make some arrangement to put some people down at Oak Ridge to be trained.

You substitute for this kind of informal dealing a formal liaison committee, I have no objection to it; I have already stated this. The function has to be performed. It is a matter of how the function is performed.

Mr. FELDMAN. There could also be the fact that you could have the formal committee, and also have the formal arrangement down at the local level so that one does not interfere with the other.

Dr. DRYDEN. I can only say I have no objection if the committee wishes to write this kind of formal liaison, but I do think there are a number of Government agencies involved in the liaison and I prefer not to see a half dozen such committees.

Mr. FELDMAN. I could go along on that except that I do not think there is any need in some instances. You would not want to have a whole series of liaisons unless it became important, but we do not have that in the case of the military. Where there is actually a good deal of overlapping or duplicating or working together involved, then it is essential to have such a committee and also in the case of the Atomic Energy Commission, where they, too, have important projects that you are concerned with. However, I can see where in connection with other agencies, such as the Weather Bureau, it might not be necessary.

Dr. DRYDEN. I do not know why it is not necessary in the Weather Bureau if you go into this extensive meteorological program. I am looking ahead, and it seems to me there will be 4 or 5 Government agencies in which liaison is required.

Mr. FELDMAN. But you will have that liaison in any event; is that right?

Dr. DRYDEN. By the kind of method that we talk about, they are less formal than a formal liaison committee.

Mr. FELDMAN. Now, at the present time the Chairman of the National Advisory Committee for Aeronautics is elected by the committee by ballot, to serve for 1 year. Now, section 4 (b) of the new proposal provides that—

The Chairman shall be designated from time to time by the President from among the non-Government members of the Board only.

Dr. DRYDEN. Yes. The reason for that is to avoid a conflict of interest. To have the Secretary of Defense as head of the new agency, for example, which would be possible if you extended this to the full membership, to have Defense representing both Defense and the new agency. To avoid this conflict of interest it is provided that the Chairman be taken from among members who do not some from Government agencies.

Mr. FELDMAN. Assuming that one of the members of a non-Government agency was the head of a large company that is contracting with one of the services or with NASA, would the conflict-of-interest provision apply there, or your reasoning in connection therewith?

Dr. DRYDEN. I think so. This is a matter which you will want to consider. At present there is no problem of industrial members on the Board because the present NACA does not award contracts to anybody.

The whole matter is on a completely technical research level. The new agency will be involved in such things and I would think that you would want to consider this problem. I assume the President would also want to consider it in appointing the members of this Board as to whether it would not be a real conflict of interest if the principal officer of some large contractor having contracts with the Government were made Chairman.

Mr. FELDMAN. If the Board as presently constituted were appointed by the President, might that not be a serious question?

Dr. DRYDEN. It depends on who he appoints as Chairman.

Mr. FELDMAN. I am talking not only of the Chairman but the membership of the Board itself.

Dr. DRYDEN. I would have to look into the details of the relationships of the people now on the Board.

Mr. FELDMAN. I think it does present a serious question.

The CHAIRMAN. Would you submit your recommendations for language to be incorporated in the bill that will meet the situation?

Dr. DRYDEN. Yes; we will.

(Letter in compliance with request follows:)

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS,
Washington, D. C., May 23, 1958.

Hon. JOHN W. MCCORMACK,
Chairman, Select Committee on Astronautics and Space Exploration, House of Representatives, Washington, D. C.

DEAR MR. MCCORMACK: During the hearings before your committee, you requested language that might be incorporated in the bill (H. R. 11881) regarding conflict-of-interest provisions (see p. 1017 of the transcript).

It appears that there are sufficient statutory provisions at present which would govern the activities of Board members. The conflict-of-interest sections

of the United States Code to which I refer are 18 U. S. C sections 281, 282, 283, 284, 434, and 1914, and 5 U. S. C. section 99.

In this connection, I call your attention to "A Staff Report to Subcommittee No. 5 of the Committee on the Judiciary, House of Representatives," dated March 1, 1958, entitled "Federal Conflict of Interest Legislation."

Sincerely,

PAUL G. DEMBLING, *General Counsel.*

Mr. FELDMAN. Section 4 (b) of the proposal before this committee provides that, "The chairman shall be designated from time to time by the President," and so forth, among the nongovernmental members of the Board. I think you answered that question, but one more point in connection with it is this:

It would seem to me that there is a possibility for embarrassment in a situation of that kind, that I would think that the President might have some difficulty in getting members who are not connected with any of the services and who might be of real value to the committee.

Dr. DRYDEN. This is the perennial problem of getting expert help in Government for such positions as Secretary of Defense or any high position.

How do you find anybody that knows anything about the subject that is not involved in some relations with the Government?

Mr. FELDMAN. That is why we require a divorcement from their past connections.

Dr. DRYDEN. Yes.

Mr. FELDMAN. So you would say that this matter requires consideration?

Dr. DRYDEN. I would agree.

Mr. FELDMAN. Now, in answer to a question put to you by Congressman Natcher, you said you never permitted the Board to hold up action.

Dr. DRYDEN. That is right. They have delegated their powers to me, for example, to begin on military research and report afterwards what has been done, and they delegate powers to make contracts with universities on research.

The present situation is that the Board has delegated powers so that there is no holdup of action.

Mr. FELDMAN. I believe you indicated that you never had to go to them for the purpose of signing a contract.

Dr. DRYDEN. That is right.

Mr. FELDMAN. But did you ever have to go to them in connection with even negotiating or entering into a contract?

Dr. DRYDEN. They cannot enter into that picture at all.

The CHAIRMAN. Doctor, I think this is a good time to suspend because there is a rollcall going on.

We will come back just as soon as possible.

(A short recess was taken.)

The CHAIRMAN. The committee will be in order.

Mr. Feldman, will you continue your questioning.

Mr. FELDMAN. Doctor, I just wanted to summarize the previous testimony. I wonder whether you will agree with me that the proposals did not consider the possibility of the conflict of laws in the changeover from the present functions of the NACA to the new

functions which would enable it to enter into contracts and actually produce space vehicles?

Dr. DRYDEN. I do not recall any discussion of this subject. I might ask Mr. Dembling if he does.

Mr. DEMBLING. There were some discussions about the conflict of laws as you have phrased it. It was felt that if the legislation as drafted were passed, this would obviate any problem between the two sets of laws that might be on the books.

In other words, this piece of legislation would repeal any inconsistent pieces of legislation.

Mr. FELDMAN. Can you point out the provision in this new proposal which would cure the conflict-of-interest setup?

Mr. DEMBLING. Conflict of interest or conflict of laws?

Mr. FELDMAN. Conflict of interest.

Mr. DEMBLING. No, sir; this is something I believe Dr. Dryden mentioned before that should be given some attention.

Mr. FELDMAN. Now, Dr. Dryden, in the Atomic Energy Act there is a specific provision which requires that the Commission receive authorizations from Congress to build facilities. There is not a corresponding provision in the new proposal.

Would you favor such a provision?

Dr. DRYDEN. This is based, I believe, on the present situation where there is no requirement in law that there be authorization. Of course, this means that the facilities are subject to points of order, at least on the House side.

We have for the past several years submitted authorization legislation for all construction. I think only in one case has it ever gone all the way through the Congress.

We have appeared before the Armed Services Committee, which is the present legislative committee. They have gone over our construction program and in many cases the bill has passed the House, the appropriation bill usually has beat the legislative bill through.

That being true, the members have not wanted to take the time to process the authorizing legislation through separately.

The only thing we would plead for is what we have under our present agreement, the simultaneous consideration of authorization and appropriations.

In other words, if you have to come for authorization one year and appropriation the following year, this runs into long delays in the securing of special facilities which may require 3 years to build.

So that if you write this in we would propose that you at least make room for the idea that both the authorization and the appropriation could be considered at the same session of Congress.

Mr. FELDMAN. Dr. Dryden, there is no provision in the new proposal concerning patents. Would you object to such a provision which would protect the Government in that field?

Dr. DRYDEN. I do not know how to answer this question in general. In principle I certainly would say that there is no objection.

I think, myself, that the patents should be handled very broadly with respect to all Government agencies. That if you get different policies in different acts you get into a lot of confusion.

At present we have taken the view and our regulations provide

that the Government reserves rights in anything developed with its money.

Mr. FELDMAN. You would have no objection to incorporating a corresponding provision into this bill?

Dr. DRYDEN. So long as we don't have different policies than other agencies with which we have to deal. That would make for a lot of confusion, sir.

For example, if we had one group in the Navy working for the agency, the Navy had different patent legislation than the new agency, you could see the bind you would be in.

Mr. FELDMAN. You would feel that the public interest requires the inclusion of such a provision?

Dr. DRYDEN. Right.

Mr. FELDMAN. In your opening statement you pointed to the fact that in 1952 a gentleman from Bell Aircraft proposed the setting up of a space committee.

Dr. DRYDEN. Not quite. I said he thought that the agency ought to begin studying what were the problems associated with space flight, what kind of facilities were needed, what kind of research is needed, in order to prepare for such operations.

Such a study was started in the laboratories. At a later date we came up with a proposal, as a result of these studies, for a special research airplane.

I would like to say that the proposal for the research airplane was in 1952 and it took all those years to get going.

The proposal for a research airplane came some years later, after the paperwork in the laboratory study had been finished.

Mr. FELDMAN. You also stated in the prepared statement that the committee regarding the study of space or regarding space problems, was not appointed until last fall.

Dr. DRYDEN. That is correct.

Mr. FELDMAN. The bill in section 2 (6) lists under declaration of policy:

Cooperation with other nations

Section 6 (4) speaks of the scientific community.

How broadly do you interpret the words "scientific community"?

Dr. DRYDEN. That, I think, was intended to be the United States scientific community.

Mr. FELDMAN. Do you include scientists abroad in the application of section 2 (6)?

Mr. DRYDEN. I would say they would be included if the policy of the Government and so on did provide in fact for their national scientific cooperation.

As the words are written, it does not restrict it to the United States, although I think the intent of writing at the time was thinking of the United States.

Mr. FELDMAN. Do you have any views regarding the inclusion of scientists from abroad?

Dr. DRYDEN. I think this is a desirable thing to do at some stage. There is the problem I mentioned before that space flight at pressent depends very heavily on military developments and that there is a security problem involved at the present moment.

Mr. FELDMAN. Are you acquainted with a proposal that was made not too long ago concerning the plan for an atomic airplane?

Dr. DRYDEN. I am familiar with it, yes.

Mr. FELDMAN. This project was under consideration for some time by the military and by the Atomic Energy people; is that not so?

Dr. DRYDEN. That is correct.

Mr. FELDMAN. And they were ready to go when a committee was appointed to look into the matter; is that right?

Dr. DRYDEN. I think there had not been approval within the Department of Defense at the time this committee was set up.

Mr. FELDMAN. Are you sure of that?

Dr. DRYDEN. I am sure of that.

By the way, I am appearing on this subject before Mr. Price's committee on Friday. I am not sure that I can go very far on it in open session.

Mr. FELDMAN. I will not pursue it any further. Are you a member of that three-man committee?

Dr. DRYDEN. Four-man. All of them all appear before Mr. Price, but I believe in closed session.

Mr. FELDMAN. I would just like to ask this question—I don't believe this will violate any security provision: How long did the committee study the proposal?

Dr. DRYDEN. The committee itself, as this particular committee, was active a relatively short time. I don't remember, but it was 2 or 3 weeks. Each member of this committee had been associated in the past with innumerable committees connected with the atomic energy propulsion aircraft program so all of us had been exposed to briefings on this subject and had visited contractors many times.

So I think it is not fair to take the time that the committee was actually functioning as the time that the people took to get acquainted with the program.

Mr. FELDMAN. Dr. Dryden, if this does not violate security in any way, I would like the answer to this question:

I understand there has been a project of shooting into orbit an inflatable satellite for air density measurements.

Dr. DRYDEN. That is the thing which you have seen here today.

Mr. FELDMAN. This, I understand, is purely an American concept.

Dr. DRYDEN. Yes. Mr. O'Sullivan, who is in the room, is the man who thought of the scheme.

Mr. FELDMAN. Would you care to tell us about it.

Dr. DRYDEN. I think I have explained it pretty completely in the testimony before.

Mr. FELDMAN. This was partof the IGY program; is that right?

Dr. DRYDEN. The order of events was that Mr. O'Sullivan came up with this idea, the possibility of doing this. It was submitted to the IGY committee by the NACA and was accepted as a part of the satellite program.

Mr. FELDMAN. When new proposals come to the NACA, would they come directly to you?

Dr. DRYDEN. Yes.

Mr. FELDMAN. Would you then submit it to the appropriate committee or subcommittee?

Dr. DRYDEN. Normally I call in members of the technical staff who are acquainted with the various specific fields.

Mr. Feldman, the way scientists use the word, or the way scientific administrators work, no one can have all the knowledge to assess a

technical program, so they get expert advice from the staff. Normally these projects are not submitted to our advisory committees for approval. They may be submitted for information, for comment.

Mr. FELDMAN. I understand that space biology is of great importance to the development of the program.

What facilities does NACA operate of this nature such as centrifuges, low-pressure changes, and so forth?

Mr. DRYDEN. The NACA operates none. It is not proposed that the NASA duplicate facilities in this field.

In the X–15 program, for example, the centrifuge at Johnsville, Pa., which is owned by the Navy, has been used for various experiments.

The idea here would be that the new agency would strengthen where necessary the work that is now going on.

Mr. FELDMAN. We further understand that upper atmosphere sounding research is a key part of the program. What rocket sounding work is the NACA carrying on?

Dr. DRYDEN. We ourselves are not directly doing rocket soundings. Our people did develop one of the rockets which is being widely used in the IGY program.

NASA will certainly have to see that there is adequate rocket sounding program. There is a good bit of information which can be obtained much more cheaply by rocket soundings in the upper atmosphere and this work must be provided for either by stimulating other people, supporting other people; it would be the responsibility of the new agency to see that this is done.

Mr. FELDMAN. I have no further questions.

The CHAIRMAN. Mr. Sisk, do you have a question to ask?

Mr. SISK. Dr. Dryden, just how urgent do you feel that this legislation is which we have before us?

Dr. DRYDEN. I think it ought to be passed at this session of Congress. Otherwise, there will be a great deal of confusion and backing and filling.

Mr. SISK. My reason for asking that question, and I may be entirely wrong and I hope you do not take this as a personal criticism, but it seems to me as I have listened all day to the testimony here that what in a way you propose is a bit of upgrading of the present committee or board and a little updating of the program rather than any specific change, and that we will wind up doing business at the same old stand.

As I say, maybe I wholly misinterpret your whole position, but you do feel that there is a need of expediting a program of this type?

Dr. DRYDEN. Entirely so. I am sorry I did not make it clear that this is a new agency, not NACA being given another job.

As we visualize the organization at the present time, there will be a completely separate line, if you like, devoted to space-flight operations which will be separate from the pure research activities that go on in the present laboratories, that a great deal of work will be done by contract with other agencies.

I do not consider it either an assignment of this space to NACA or operating of NACA, but utilizing the nucleus of the people who are experienced in some of the technical fields needed in space; namely, aerodynamics, propulsion, and structures, supplementing those people and facilities at a value of several hundred million dollars, with a

mechanism for utilizing other groups in the country in the space flight program.

Mr. SISK. You stated earlier today, and I agree with you, that the NACA had done a good job for 40 years and has a good record.

Yet you agree that there is need today, because of recent events, for a better type of program or for more expeditious action.

Dr. DRYDEN. A different type of program, a civil hardware development and space operations program in addition to the research work which the NACA has done and will continue to do.

Mr. SISK. Many of the witnesses who have been before this committee, of course, lean more toward the idea of a commission type, a 3- or 5-man commission with a specific job and full-time duty.

Of course, your recommendations are contrary to that and maybe you are right.

I do not propose to disagree at this moment, but I have felt that maybe you did not feel the urgency. I was curious to know whether you felt that the NACA as it is presently constituted can go ahead and do the job we want done.

Dr. DRYDEN. When you say as presently constituted, no; this is a new agency. There will be new people; there will be new organizations associated with it.

Mr. SISK. That is all, Mr. Chairman.

The CHAIRMAN. Are there any further questions of Dr. Dryden?

Mr. KEATING. On that point, is it not a fact, Dr. Dryden, under the terms of this very measure the NACA goes out of existence and its duties are absorbed into the NASA?

Dr. DRYDEN. That is correct.

The CHAIRMAN. Thank you very much, Doctor. We appreciate your appearing before us.

For myself and the members of the committee, I express to you our thanks.

Dr. DRYDEN. I thank you very much for the very friendly hearing that you have given me even when we have differed on some things.

The CHAIRMAN. Well, you are going to make some suggestions along the line we requested?

Dr. DRYDEN. Yes, sir.

The CHAIRMAN. The next witness is Dr. Simon Ramo, vice president of the Ramo-Wooldridge Corp., of Los Angeles, Calif., and president of the Space Technology Laboratory which is connected with the corporation.

The Chair is going to yield to Mr. McDonough.

Mr. MCDONOUGH. Thank you, Mr. Chairman. I appreciate the courtesy.

For the benefit of the committee, I would like to say that this is the first witness we have had from industry on this very complicated subject, and I think a very capable and competent witness because of the broad experience he has had in the practical application of these new scientific developments in space vehicles, missiles, rockets, and other things.

With Dr. Ramo is Mr. A. F. Donovan, Director of Aeronautical Research in the Space Laboratory of Ramo Wooldridge, who, I understand, will also testify.

So I am happy to welcome you to the committee, Dr. Ramo.

STATEMENT OF DR. SIMON RAMO,[13] EXECUTIVE VICE PRESIDENT, RAMO-WOOLDRIDGE CORP., LOS ANGELES, CALIF.

Dr. RAMO. Some of the important issues underlying both a national space-research program, as distinct from military space programs, and the formation of a civilian research agency to carry out such a research program independent of the Department of Defense can be stated as a series of specific questions. These are listed below, together with the writer's opinion as to the answers.

In addition, there are attached hereto three other documents, as follows:

Appendix A. A recent, unpublished paper, "Man in Space—An Evaluation and a Justification,"

Appendix B. A copy of a speech presented to the Air Force Association at its Annual Jet Age Conference on February 28, 1958, "The Potentialities of Space Weapons Systems."

Appendix C. A reprint of a paper published in the Astronautics Journal of the American Rocket Society, August 1957, "ICBM—Giant Step Into Space."

These three attachments provide elaborations on some points believed to be pertinent to the problem, showing the relationship of space-research projects to military projects, and generally commenting on the importance of space projects for both military and nonmilitary application.

Question. Are there important space-research areas exclusive of military space-weapons systems?

Answer. Much valuable investigation of other planets, the moon, and the characteristics of the space between these bodies appears today to involve only exploration and pure research into the laws of nature, with no clear military application. For example, answering the question as to whether there is life on Mars does not have any obvious military consequence.

Space research defined in this way may well provide information on the basis of which military weapons systems of a radical and important kind will later be invented. But this kind of generalization can be used for all forms of pure research. All new discoveries in science can be expected to open up new applications, both military and nonmilitary.

Question. Does space research require or deserve a separate agency?

Answer. Research in medicine, biology, nuclear physics, and other physical and life sciences all promise benefits and can all be classed

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[13] Ramo, Simon (rā'mō), engring, exec.; b. Salt Lake City, May 7, 1913; s. Benjamin and Clara (Trestman) R; B S, U. Utah, 1933; Ph. D., Cal. Inst. Tech. (teaching fellow), 1936, m. Virginia May Smith, July 25, 1937; children—James Brian, Alan Martin. Various positions including sect. head gen. engring. lab., head physics sect. electronics lab. Gen. Electric Co, Schenectady, N. Y., 1936–46; lectr. Union Coll., 1941–46; with Hughes Aircraft Co, Culver City, Cal., 1946–53; dir. research electronics dept., dir. guided missile research and development, v. p., dir. operations; v. p., exec. dir. The Ramo-Wooldridge Corps, Los Angeles, 1953—— research asso. elec. engring. Cal. Inst. Tech., 1946——; dir. Thompson Products Inc, Pacific Semiconductors, Inc. Mem. industry and ednl. adv. bd. Arnold Engring. Center USAF. Awards from Inst. Radio Engrs., Eta Kappa Nu. Fellow Inst. Radio Engrs. (bd. editor proc.), Am. Inst. E. E, Am. Phys. Soc.; mem. Sigma Xi, Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu, Theta Tau, Sigma Pi Sigma. Author: Fields and Waves in Modern Radio (with John R. Whinnery), 1944, 53; Introduction to Microwaves, 1945. Contbr. other textbooks, numerous articles tech. publs. Patentee microwaves, electron optics, guided missiles, automatic controls. Home: 276 Tavistock Av., Los Angeles 49 Office: 8820 Bellance Av., Los Angeles 45.

as vital in the long run to our security or our happiness. If all such basic research is controlled by the Department of Defense, it is justifiable to fear that we may not explore sufficiently the longer range aspects of science. In this sense, it is reasonable to consider a separate civilian agency to direct and sponsor nonmilitary space research. But this will work to the detriment of the Nation if, in the process of trying to separate away pure research in space from research and development necessary to insure military space capability, proper consideration is not given to the extremely important connection between these two aspects of space. No matter what basic space research the new agency may carry on, no arbitrary rule should prevent the Department of Defense from engaging in that space research it may deem essential to sound advanced military developments. In other words, the new space agency should not be thought of as having a monopoly on space research.

Moreover, study of a separate agency for space research can hardly be considered thorough, unless it is recognized that space research must compete for the Nation's limited physical and technical resources with other important long-range research as well as with urgent military applications of space. We have to be sure that there exist efficient means for investigating whether space research is going to provide the Nation with more potential scientific information of benefit to us and mankind in general than other competing fields. Is it better to cure cancer, or to find out if there is life on Mars? Who will answer such questions? It is obvious that the professional scientist alone should not be handed the decision authority over whether it is better to land a man on Mars or to spend the same resources on attempts to control the weather on earth. The scientific experts can help by indicating how much can be accomplished in a given time at a given cost, but ultimately the people as a whole, through their elected representatives and their Government officials, must make these choices, because they depend upon factors of broad national scope.

But this suggests that if we are to have a separate agency to direct Government-sponsored basic research outside the scope of the Department of Defense, then that agency should cover not just space, but other aspects of the Government's research program as well, including the nuclear, medical, biological, and other fields. Otherwise, it appears to be equally deserving to have a special agency for each and every important field, and with this, of course, the cumbersome and unsolved problem of refereeing objectively the distribution of resources amongst these.

Question. Granted a separate space research agency, how closely must it work with the Department of Defense?

Answer. There must be exceedingly close ties between the programs of the space agency and the Department of Defense in order to utilize to the fullest the funds assigned to the space agency. This comes about primarily because space research is very expensive, particularly as to the required apparatus, the facilities for testing and fabrication, and the development of countless auxiliary techniques for measurement and handling of apparatus and data. Unless the new space agency relies heavily on the big boosters, the detailed hardware, and the launching facilities that the Department of Defense has to provide anyway for its urgent large-scale military programs, the budget

of the space agency will have to be many times greater to approach the same potentialities in getting results. Indeed, to the first approximation, basic research in space, beyond foreseeable military applications, can be described as a small addition to the large military space program. If the agency obtains funds beyond such a small addition, it probably will be a disproportionate expenditure of funds in space research as compared with other forms of research also important to the Nation and deserving of Government support.

I would like to elaborate on this in view of some of the discussion I heard this morning.

In particular there was mention of two examples of peacetime, nonmilitary space research or space applications. One was in the field of communications, to improve worldwide communications, and the other was weather prediction and control.

Now, I submit to you gentlemen that that part of our Nation, that group that has the greatest need for improved communications and as a result is already involved in the initial steps of planning improved communcation systems using satellites, an indicated approach, is the Department of Defense.

We have facing us a new concept of "one world simultaneity," of military operations, in which some launching activities on one part of the earth's surface can mean, only minutes later, the destruction of a vast part of the rest of the globe. It is obvious that the military has an urgent need for a class of communication system superior to what exists today in which in effect the whole world is tied together in a vast integrated network that allows military command to be in communication with any part of its operations.

Communication's theory today suggests that satellites are going to be an important ingredient of such new communications systems.

As the larger boosters become reliable, the only step yet to be taken, these larger communications systems will become possible and it is my opinion that the Department of Defense, if it does its job properly, will have to seek funds for an urgent large communication system.

Now, if we talk about weather prediction and control we have something similar. We can talk about various groups, the farmers, the military, even those engaged in the entertainment business, the airlines certainly, that have a need for improved weather prediction.

But of all these groups, the one that stands at the top of the list, based on national urgency, is the military.

I can even cite such details as that the first operational ICBM's have an error contribution to their "miss distance" that comes about because we are not in a position to predict accurately the surface wind over the target.

And, in fact, if such prediction could be made more precisely the effect is to increase the effectiveness, the equivalent weight, of the bomb that is carried.

Now, this is by way of only one of many examples that the Department of Defense has the No. 1 need for improved weather observations, prediction and, eventually, control.

One final example is the large rockets which were mentioned a number of times. If we desire a million-pound thrust for various purposes, it should be recognized that acquiring that million-pound thrust means merely an extension of the large engines that are already flying and in production on Department of Defense programs.

I cannot give, in an open session, the thrusts that are available today, but it means something like a 2-to-1 increase in dimensions to get to the million pounds—no basic change to entirely new processes for combustion or entirely new fuels.

So that the quickest way to get a million-pound thrust is by an extension, you see, of a large military program.

By these remarks I do not seek to give the impression that there should not be a separate civilian space agency.

Rather, what I am trying to express is the belief that, if we properly assess the importance of space to defense and if we plan that the Defense Department shall be a strong department that primarily is responsible for defense, then the new space agency is one of the groups and not the only group in the Nation that provides space research. There must be a great deal of close coordination.

Just such coordination, incidentally, has existed between NACA and DOD on aerodynamics.

The Department of Defense has developed its airplanes, making use to a considerable extent of information that comes from NACA, but no effort has been made in the past to give NACA a monopoly on aerodynamics.

Question. Can NACA serve as the basis for the new space agency, or is an entirely new organization needed?

Answer. In my opinion, NACA is an ideal starting organization for the new agency. It enjoys an outstanding reputation for results and has a good staff. It also has very considerable background and strong beginnings in space research.

However, it will be necessary, in order to properly exploit the national resources available for space research and to minimize the required expenditures, to augment NACA with planned supporting and parallel research contracted for with university, industry, and other private groups outside of the Government. Of course, these additional research tasks should be administered by the same group that administers the "in-house" work by the basic (NASA) Government organization.

Question. Considering only nonmilitary space projects, do you believe that any project in which the Nation is interested and which involves any vehicle in outer space should permanently be managed by the separate space agency?

Answer. In time, a typical so-called space project will involve a wide range of equipment and engineering developments quite apart from the individual piece of equipment that may be in outer space. For example, a weather prediction and control system may encompass billions of dollars worth of equipment and employ tens of thousands of people spread geographically over the entire Nation and maybe a good many parts of the world. This system will consist of a number of vehicles in outer space costing some millions, or at most tens of millions of dollars. The system will include also observations of all kinds made from airplanes and balloons, and from ground stations all over the world, including airborne and ground radars. It will include also thousands of communication links going into central points where data are stored and where data are computed in massive electronic computers, where automatic selectors of past data feed into data processors together with new incoming information to form conclusions,

with the results communicated to various parts of the world where all kinds of actions are taken. I would imagine, in other words, that a weather prediction and control system a decade or two from now will consist of a multibillion dollar installation with the space vehicles' parts a relatively minor part of the whole. It would be illogical then to think of such a system being permanently contained and controlled by the space research agency, which should instead limit itself to research.

An analogy to the automobile industry may be helpful here. Let us imagine that we are back in the days when someone has succeeded in building the simplest possible prototype of an internal combustion engine, and has succeeded also in tying that to the wheels of a simple wagon of some kind, and we are thus aware that the horseless carriage era has arrived. We are in a race with Russia to see who can propel such a vehicle down the road for the greatest distance and the greatest speed, one having succeeded in doing it for 500 yards, the other for a mile, with speeds of a few miles an hour. How difficult it would have been at that time for us to have imagined a multibillion dollar industry involving gasoline stations by the hundreds of thousands throughout the world, with millions of people employed in such auxiliary tasks as handling of spare parts, making and selling tires, writing of advertisements for the automobile industry, special kinds of steels and chromium, developments in plastics and glass, and numerous auxiliaries such as shock absorbers, speedometers, etc. If we had at that time created a special research agency in the Government to control internal combustion engine research, would we expect that agency to go on in perpetuity to direct and control the activities of the gigantic automobile industry? It is in this sense that I suggest we look ahead to such items as have been described above as weather prediction control, and realize that what we now regard as experiments in space will eventually prove to involve large new industries, many additional engineering fields, with the space components, now so conspicuous, being virtually lost in the myriad of equipment and man-machine problems that will develop.

Question. How can we best go about creating the content of the space-research program?

Answer. There are literally hundreds of important experiments worth doing in space beyond those that have immediate military potential. Data collection in space is valuable to many fields of science. All scientific groups, such as the geophysical, astrophysical, and biomedical, can be expected to originate enough requests for data collection that each group alone could use up the entire budget assignment. The directors of the new agency and their scientific advisers must first list these desired experiments, these requests for information on space. Then they must compare this with another list, a schedule of activities and availability of apparatus, facilities, and techniques from the large military space and ballistic-missile programs. The first important exercise, I believe, is one of matching these to the greatest extent possible, scheduling the easy things first whenever they are logical steps and whenever they can be added at low cost to the military program. Expensive dead-end experiments should be severely scrutinized, and large-scale development of major boosters, major testing ranges, and the like, when they appear to have narrow and short-lived application, should be avoided.

In the end, the specific experiments, whether to orbit Mars, make measurements near the Sun, put biological samples into space, or concentrate more heavily instead on cosmic-ray measurements in space—these must all be decided by compromises amongst experts who know the availability of hardware, the schedule possibilities, and the relationship to military programs, and who combine appreciation of the several fields of science. It is unrealistic to tie a decision concerning a separated space agency to any specific program suggestion, however broad. Whether the agency is or is not a good idea clearly depends not on resolving debate as to whether we can or cannot put a man on the moon in 4, 6, or 10 years, but rather on some of the broader issues enumerated above.

Mr. Chairman, that concludes my statement.

The CHAIRMAN. I notice you have also, accompanying your prepared statement, an evaluation and a justification of man in space prepared by you.

Dr. RAMO. Yes, sir.

Also, you have appendixes B ond C, and they will also be made a part of the record.

(The material referred to follows:)

APPENDIX A

MAN IN SPACE—AN EVALUATION AND A JUSTIFICATION

By Simon Ramo, president, Space Technology Laboratories, division of the Ramo-Wooldridge Corp., Los Angeles, Calif.

No one now doubts that at some future date man will land on the moon and return. He will visit the other nearby planets. We may even be expected in future years to start colonies on these other space bodies.

We are sure these things will happen, because we essentially know how to make them happen today, and a good deal of what is needed in the techniques and in the actual apparatus will be available automatically from urgent military programs, such as the intercontinental ballistic missile development.

But despite the important start that military developments will provide to us in making it easier for man to enter space, it will still cost a substantial fraction of the Nation's technical and physical resources to conduct "man in space" experiments and to attain the end result of true capability and accomplishment in putting man into space and on these distant bodies, and to bring him back safely.

While we have become aware of our approaching capabilities for conducting such experiments, we are also beginning to realize that, in both the fields of urgent military development and pure conquest of the unknown, there are many more valuable tasks that we cannot possibly do all at once. Whether we like it or not, we and every other nation on the globe have distinctly limited resources compared with the possibilities we are capable of imagining. It has become true that imagination and idea promotion are the easy-to-get commodities. We must now clearly combine wisdom with imagination. Our future security as a Nation, and our ability to contain the world in a reasonably stable and happy state while making transition to the new, more technical society toward which we are headed, will both hinge on how well we make our decisions. We must be superior to other nations in what we choose to do out of all that we can do. The world may be inherited not by the nation that first escapes from the earth on the grandest scale, but rather by that nation that does it just often enough and does a lot of other things besides.

Let us take, for example, this question of putting man in outer space, in an orbit, out to the Moon and back, or out to Mars or Venus. How shall we class this effort? Urgent, or relatively low priority? As a scientific experiment will it yield us, do we think, more than the same resources committed to other explorations of the many unknowns that remain in nature? As a military poten-

tial, does it offer the possibilities of weapons systems superior to those in which man is restrained to the earth and a limited air-filled region above it?

It can be assumed that man's curiosity about the many unknowns of outer space will not be permanently satisfied by the mere placing of meters out in space. Man will have to go there to see for himself. We can investigate by instruments alone a very large fraction of what there is to know about the other planets and about the conditions in space between planets. But if we ask finally for sufficiently detailed examination of conditions and matter on the other planets, the instrumentation required becomes so complex, heavy, and difficult that man at some point becomes the cheapest, lightest, and most practical in strument for making such examination. Ultimately, in other words, man's appearance on the moon and the other planets is inevitable, even though what we shall learn and how useful that new knowledge will be is difficult, if not impossible, to predict.

But is it urgent to put man in space? Does national survival hang on it? If so, then 1 of 2 things must be true. We must see some direct military weapons systems requiring man in space. Failing this, we must identify some missing scientific knowledge, the gaining of which requires visitations by man himself to the moon and the other planets or to the space between them, which scientific information will then make possible the design of improved weapons systems that will control the earth. If we see neither a direct military requirement for a man in space nor any scientific data that man must go out and collect on which a necessary military strategy depends, then it would appear that putting man in space must be classed under the heading of long-range speculative research and exploration. In terms of national emergency, this could then be far from the highest priority project.

Now, there are those who believe and say that it is urgent indeed to put man on the moon or, generally, in outer space "To control the moon is to control the earth," these enthusiasists will tell us. When we ask why, the answers tend to be too general to criticize. Of course, unsound justifications are very common to. We often hear the mistaken impression that a bomb dropped from a satellite will fall to the earth. Of course it won't. It will reach the earth only if it is pushed away from the satellite with the right amount of force and with controlled direction, the whole launching operation being more difficult than that of launching an ICBM from a point on earth. Also, the flight would take very much longer. More important, the cost of putting up a satellite with its associated equipment capable of doing useful strategic bombing would permit the building of a very large number of land-based or submarine-based long-range ballistic missiles to drop the same H-bomb. In terms of insuring that we have an invulnerable retaliatory capability at a cost we can afford, putting our H-bombs out in space or on the moon, with the necessary means for assuring that they will come down when desired to the right places, looks like a different but poorer way of doing it. Outer space is new, but so is the bottom of the ocean; this does not mean we should put our retaliatory force there.

Even if we went to the greatly more complicated and costly, and apparently poorer way of retaliating by putting our H-bombs in orbit out in space or on the moon, it is not at all clear today why a man would be helpful. So we have two hurdles to clear in trying to see the logic behind such proposals. Space weapons do not look today as good for bombing as does the ICBM, which is a space weapon in actuality, but one that is under our control at home until we are ready to use it. The ICBM uses space to the extent that it pays off. It buys us the most important advance over nonspace vehicles, a great reduction in time between the initiation of the attack and its effect. The second hurdle is that everything that we might plan to have the man do, if he were out in space participating in the H-bomb raid, we can also arrange to do by remote control with the man remaining on earth.

But the enthusiasts go on to say it has always been true that the "high ground" gives the adversary an advantage. The moon is up there higher than any point reached by an intercontinental ballistic missile, and of course by any manned airplane. The moon looks down on the earth, therefore it controls.

We are too sophisticated today in both science and military strategy to accept such a generalization. Once we have the power to hit any point on earth from any other point on its surface in a period of time better measured in minutes than in hours, we are going to be extremely reluctant, of course, to make that same trip by a new longer way, out to the moon and back. The moon has an arbitrarily limited, distant path. Why should that particular region out of all space be so specially useful in a clash between two nations that occupy and

contest the surface of the earth? A 2-dimensional analogy will help to understand the 3-dimensional space problem which now confronts us. If the earth were covered everywhere by ocean, with the exception of a small island containing 2 opposing groups, we might imagine that the ocean around the island would be used for transfer of people and things between the 2 groups in peace and war. Part of the ocean, at most a few times the area of the island, would be used. It is not at all clear that either of the two groups would have anything to gain by seeking to control some part of the ocean very, very far away, even if there were a little rocky bluff sticking out at some distance that might be occupied at great effort by the other group.

To those who think of the moon as looking down on the earth, it can be pointed out that from the standpoint of the moon it is we who are above it. The concept of high and low ground is obviously a relative thing, and when we start dealing realistically with 3-dimensional space and recognize that "the earth is round" and that the moon is many earth radii away, we begin to see how wasteful of resources could be an attempt to involve the moon in our plans for self-protection just on the basis of a hunch extrapolation.

Of course, if the moon or one of the other planets becomes some day a source of vital material without which we cannot maintain our position as a nation, then obviously we cannot be without the means of obtaining that material while our rival goes about monopolizing it. Only research can disclose such a possibility. We have no reason for assuming it today.

If the Russians "take" the moon, it could be the same as their having added something to that large section of ground presently under their control, known as Siberia, only the additional new Siberia will be very much farther away, very much harder for them to reach, so that anything and everything they do in connection with trying to make that real estate useful to them will put a strain on their total capabilities. The effort might swing the strength balance more in our direction than away from us.

There is, of course, the aspect of psychological warfare introduced by sputnik. So long as the world is going to be influenced for or against our way of life and for or against our leadership, in proportion to our apparent scientific superiority over the Russians, just so long must our research efforts include demonstrations to the world of our scientific prowess. Space explorations and space research are strong candidates for this kind of psychological warfare. But there are other spectacular fields. We might do as much or more to prove our superiority over the Russians and gain the benefits of worldwide respect and admiration if we were to cure most forms of cancer It might cost less than putting a man on Mars. It would also imply a new military capability, because any nation that can cure cancer ought to be able to provide new terrifying forms of biological warfare with which to frighten its enemies. Similarly, it might be better to put more of our resources into harnessing the H-bomb, providing controlled thermonuclear energy by relatively cheap techniques—theoretical possibilities that only research can change to a practical reality.

We conclude tentatively that we cannot justify man in space based upon its being obviously most important pure science experiment for man's future happiness, or based upon generalizations about controlling the high ground, or based upon this being the only way to conduct psychological warfare with science.

Is there, nevertheless, a requirement for man in space experiments tied to our chances of survival? I think there is. But in order to understand it, I think it is necessary to understand the nature of military technology as it is developing now and as it will take shape during the next decade.

The military experts can list for us a number of seemingly permanent, urgent tasks These include deterring aggression by having an inevitable retaliatory capability to wipe out the enemy's nation immediately after an aggressive act on his part. It means the ability to handle small wars. It means military reconnaissance and intelligence. It means worldwide communication. It means defense systems to minimize the effect of enemy surprise blows.

Planning of such capabilities has now reached a new peak of difficulty. We have rapidly moved to a "total-earth-simultaneity" class of military operations. A number of launchings taking place at one point on the earth's surface can wipe out a nation many thousands of miles away, in minutes. A military operation now appears to require considering the entire earth as a network of men and machines, all integrated in a huge complex of automatic and semiautomatic devices with human operators interspersed throughout the system. Observation, analysis, decision making, and implementation of decisions are all tied together

in an intimate and rapid relationship, even though the myriad of people and equipment covers lots of geography.

If we choose, for example, to defend our Nation by trying to shoot down enemy bombs before they explode, we must be watching the enemy territory by radar and other devices. We must be searching the skies. What is observed must be discriminated and analyzed, information from observations thousands of miles away must be brought together, difficult computations made, decisions reached as to what under our control will rise to the defense, and where. We invest in these systems many billions of dollars, and we place in the hands of these systems our security.

The systems designer—that collection of brilliant military, scientific, and production experts who must translate the military requirements into a workable new man-machine complex—must break down the tasks into its necessary elements, and must understand the capacities, speeds, locations, and characteristics of each vital function of the entire system. They place a bomb here and a communications channel there, call for an electronic computer elsewhere, human brains somewhere else—all arranged to do the best possible job with the available resources.

You will notice that I have spoken about resources in the sense of man-machine partnerships. What we have, to accomplish the military task, are people and things that people can build and operate. When we speak of an automatic system, we never mean one which has no human component, even if in some systems the human being appears to do little more than push the button to launch the whole operation. Realistically, when we divide up what has to be done—observe, compute, decide, move—we find that sometimes a synthetic machine can do the job better and sometimes the human machine is better. The human being has the equivalent of 10 billion electron tubes in his brain. This is millions of times more than the largest synthetic brain, our biggest electronic digital computer. At the same time, despite this tremendous capacity and despite the input and output mechanisms, the senses, and the muscles that tie to the brain through its nervous system, the human brain is unsuitable for certain other tasks. For instance, we cannot add 2 single digit numbers, such as 2 plus 2, faster than, say, about 1 a second. Very often we require that such simple additions be made thousand or even millions of times per second. The brain can be qualitatively superior to the task and therefore improperly used, and yet quantitatively inferior. On the other hand, the brain can look at a complex picture and in a flash of a second integrate the details of that picture with background stored information, and arrive at a conclusion. We can answer in a second whether we recognize someone we have met out of some thousands of people of our acquaintance—something we cannot do so easily with a machine. Man is not able to withstand certain environmental conditions of vibration, or temperature, or humidity, or lack of oxygen, but we can design machines to work under these conditions.

These two competitors, man and machine, win out, one over the other, for individual specific tasks. However, when we come to a very huge weapon system, we find that there are literally thousand of definable, separate tasks. It always happens, and it probably always will continue to happen, that we can best meet the requirements by a partnership.

Granting this, then, let us compare two nations. Suppose one nation considers all the military tasks that it can conceive of in the future. It recognizes them as very complex, requiring a large number of separate components, some human, some synthetic. It prepares to be able to use each kind of component, the human and the synthetic, in every part of the system. It says, in effect, the specific machines and the specific pattern of man-machine relationship to do strategic bombing, defense, small wars, reconnaissance, intelligence, logistics, etc., cannot be clear to us for all succeeding years. What is clear is that we must have the components around which we can develop the best patterns and arrangements. Thus, we must have computers with speed and capacity. We must extend the radar and other techniques to be able to see at the greatest possible distance. We must have engines that produce high thrust, so we can bring instruments or people up to high velocities. We must be able to reach distant points around the earth or away from it. We must develop ever better warheads. And we must become more and more skilled in understanding how to combine all of these elements to do our job at the least cost.

The other nation, the rival, also recognizes the growing complexity of modern weapons systems. It also grants a man-machine partnership, and realizes that new patterns not all evident today will be needed. It equally clearly sees the

race as one for wisdom in the use of limited technical and physical resources. It also sets out to develop the basic components of the machines and the training of the human operators to provide the greatest of flexibility for its weapons system inventors—all this except for one decision that this nation alone makes in contrast with the first: It decides that man will never be needed in space, despite recognizing that for some hundreds of pounds man provides the greatest possible concentration of equivalent electronics and control that nature has yet devised. This nation edicts at the outset that man is ineligible for becoming a space component. It does this because it sees the disadvantages of catering to man, the extra weight needed to bring him back safely and to support him in space, the special requirements on propulsion and trajectories in order to be easy on the man as to acceleration and, moreover, it does this because it is unable at this moment to prove that man is absolutely needed in that role in any weapons system that it can now conceive.

These two nations start out to develop their weapons systems of the future. One group has the maximum of flexibility, the other has some prohibitions. Which will win out?

We do not know. If it were to turn out to be true in 1970 that every weapon system projected by the nation that leaves the man out is as good as any weapon system developed by his rival who is prepared to include man in space, and especially if even the second nation elects after all to leave man out because they prove him more of a handicap that an asset, then it is clear that the nation that made narrow decisions gained. The other, it would appear, wasted some of its resources pursuing something from which it received no advantage.

On the other hand, if weapons systems are invented to take advantage of man in space and one nation has ruled itself out of the race by a premature decision, it will obviously be the one to suffer.

This clearly means to me that the United States must prepare for putting man in space, but that we should do it on a controlled basis What do I mean by controlled? How does anyone tell what is the right amount of effort? The answer, I think, is arrived at in this way. More urgent tasks, that is, those that appear to involve our ability to maintain ourselves in the near future, must be given higher priority. Investigations preparatory to putting man in space should be made first and foremost when they can be made with little cost because they are added to the unmanned weapons system developments which must go on anyway at high priority. Long leadtime items must be started. We cannot afford to be in a position that denies to us for many years the development of man-in-space weapons systems because we failed to start certain parts of the system early. Thus, for example, if man in space and return requires larger thrust than we need for ICBM's, let us start larger thrust engine work now, because we have seen that large steps in propulsion cannot be made overnight. In this way the cost will not be enormous.

The effort will not be a controlled one, and we will not show wisdom in assigning total technical and physical resources, if we launch an all-out crash program for some weapon system that involves man in space, with all of its supporting facilities, production lines, logistics, and training and handling equipment, based only on some general notion that eventually man must be found in space so why not now. In particular, we must avoid fixing on a very specific, firm, completely specified military weapons system using a man in space if there has not been reasonable justification for such a system's being better in some major way than a competitive system that is cheaper and easier to attain, in which the man is left on the ground. Laying a technological basis early for weapons systems of the future is not the same as starting a complete weapons system program prematurely.

And what do we do if Russia beats us to some experiment involving man in space? This is part of a general problem we might as well face up to now as a Nation. The United States is ahead of Russia in many fields, behind in others. It is going to continue to be this way. We cannot simultaneously plan to be ahead of Russia in everything, an end we will never succeed in attaining, and at the same time expect to use our limited resources to the best advantage in assuring our dominance, or at least our survival, on this earth. We simply cannot be first in everything. We should not allow a misguided attempt toward such an objective to keep us from being first in the advances we think are the most important to us.

APPENDIX B

THE POTENTIALITIES OF SPACE WEAPONS SYSTEMS [1]

By Simon Ramo, president, Space Technology Laboratories, Division of the Ramo-Wooldridge Corp., Los Angeles, Calif.

It is difficult to be objective today about space. That the Soviet Union is not a backward scientific power had been clear for a number of years to those who studied the problem from other available evidence, but it was an engineering feat involving outer space that proved it to the world. In the partially emotional environment that now exists, it has become fashionable and safe to have certain views about space technology. There are many who believe and say, for example, that of all pursuits in pure research in which our Nation might engage the most important is certainly research in outer space. Furthermore, some now assume that if a piece of apparatus or a human operator on any mission is required to spend a good part of the operating time of the mission in outer space, then that must be a better way of accomplishing the task than any approach in which all parts of the mission are accomplished within a relatively thin region near the surface of the earth.

Certainly penetrating outer space has a special fascination to the explorer instinct in man. We cannot predict what new laws of the universe will be exposed to us when we remove the handicap of observing through the earth's atmosphere, and we are curious about life on other planets. And, of course, the use of the space above the atmosphere is important to the military as well. The ICBM is a good enough example of that fact.

But it is far from clear that a dollar spent in exploring outer space will buy us more security in the short or the long term that the same dollar spent in other scientific fields also closely associated with military potential. Furthermore, despite the enormous psychological effect of successful space experiments at this time in civilization's history in influencing the people of the world to believe in the superiority of the nation that performs well and early, it is also not self-evident that each dollar or each hour of effort expended on space experiments buys us more of such influence as that same effort expended in competitive projects. It is even unrealistic to talk about our attaining space supemacy—that is, if supremacy means controlling all of the space that surrounds this earth and denying entry into that space to every other nation. This ambition can be ruled out for any nation today, I believe, if not by technical considerations alone, then by a combination of technical and economic factors.

We cannot be first and foremost in today's world in every aspect of science. In particular, in space technology there are so many experiments that are practical to perform, so many attractive systems for military or peacetime applications that can be brought into being utilizing outer space, that any country with substantial resources choosing to work in this field must be expected to conceive and carry out some favored project ahead of other nations. Thus, if we send up many satellites, for worldwide TV relays, general navigation, communications, and mapping, and land instruments on the moon, and orbit around and take pictures of Mars, that still leaves to another nation during this same time period the planet Venus, satellite systems to participate in weather prediction and control, and manned space stations.

Since we must maintain our security in a world in which we cannot be overwhelmingly dominant in every aspect of the technology that affects security, we must be wiser than any strong opponent in what we choose to do with our limited resources. We need the most objective thinking possible, even on matters affecting space. Those of us in the scientific and industrial field who are specializing in problems relating to space technology must put forth facts about the nature of the field, its potentialities, its limitations, the relationship of one project to another—and we must attempt not to prejudge the relative importance of projects in this field as compared with non-outer-space programs. Such comparisons involve judgments that cannot be left entirely to space experts, who should be content with providing the necessary authoritative inputs on the basis of which the decision can be made at a level where all competitive ways of using our resources can be considered.

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[1] Presented at the Third Annual Jet Age Conference of the Air Force Association, Washington, D C., February 28, 1958

What are some established facts in this space field? Foremost today, and perhaps for many years to come, of all the space weapons is the long-range ballistic missile. There are several reasons for the present and anticipated future special position of the long-range ballistic missile. As a scheme for delivering nuclear warheads thousands of miles away, it introduces such changes in the flight duration and other characteristics as compared with earlier techniques as to influence by an order of magnitude many of the problems involved in preparing for, resisting, surviving, or retaliating against an attack.

But long-range ballistic missiles still would not occupy a role of top, established importance out of all space weapons systems for very long unless they were capable of considerable growth potential. From experiments and analyses well along today, we know how great this growth potential is. In future years we may expect strategic bombing capability by the new long-range ballistic missile approach based on improved or new techniques, which, compared with the first operational capability of such missiles, will have the advantage of greater simplicity, smaller sizes and weights, more reliability, higher accuracies, less cost, and weapons system as a whole lending itself to greater automaticity, readiness, and larger scale production. It would appear that ultimately such barriers as knowledge of the physical constants of the earth, basic properties of materials, and fundamental limitations applying to guidance and propulsion, must set limits on what we can do with long-range ballistic missiles. It turns out, actually, that extensions beyond the present engineering art, now seen to be practical for the future, will meet foreseeable military requirements, without reaching these barriers. At any rate, the cost, performance, and physical characteristics of first-generation long-range ballistic missiles are not today controlled by such fundamental-science limits, but instead by the cumulative effect of a host of individually small, practical, detailed, engineering design, manufacturing or operational problems.

Now, it is inherent in the quantitative relationships amongst payload weights, engine thrusts, guidance accuracies and structure factors, that when long-range ballistic missiles are developed a whole series of parallel or additional space weapons systems developments become completely practical using the existing components and techniques. For instance, the thrust required for Thor, Atlas, and Titan is such as to make possible the launching into orbit of payloads of sufficient size to carry the apparatus required for international TV hookups, weather observation, world mapping, military reconnaissance, early warning systems, navigation stations for further space operations, scientific data collection, and, of course, for orbiting dogs. As to accuracy and control, it is generally easier to arrange to miss the earth and orbit around it than to hit some militarily useful, small area on its surface thousands of miles away. Thus, the ICBM guidance system, for example, is much more than adequate to take care of orbiting requirements for virtually any application that is worth considering from other standpoints. Also, the ICBM solves the problem of bringing a respectably large payload up through and outside the atmosphere to a velocity almost enough for orbiting. Once this velocity range is attained with large payloads, the additional increment of velocity to permit escape from the earth is a relatively easy addition. Finally, the ICBM nose cone encompasses the major physics and engineering advances required for successful reentry back through the atmosphere.

Something similar can be said with regard to the placing of instrument payloads on the Moon or in orbits out to the nearest other planets, Mars and Venus. Again, the techniques of Thor, Atlas, and Titan, and the actual hardware available from those programs, give us almost all that we need. It thus becomes practical to execute a large number of important scientific experiments.

These then are some facts concerning the ICBM's, satellite systems, and closely related space projects, all of which use similar hardware. All such projects can be accomplished relatively quickly and relatively easily compared with the first big step of developing the large-scale hardware, the corresponding techniques, and the supporting industry and facilities.

The situation with regard to manned space flight is somewhat different. As to man's ability to withstand the special problems of space, there is some fragmentary experimental evidence and substantial theoretical basis for the assumption that man can survive extended space flight. But generally speaking, what man needs in space to survive and to insure safe landing on the earth or elsewhere, translates into apparatus complexity and much additional weight. ICBM hardware is somewhat marginal for even the simplest true space flight with a human passenger, and needs to be modified or extended. For a substan-

tial manned experiments, such as landing on the moon and, of course, safe return to earth, propulsion systems substantially larger than or different from the ICBM are required. However, practical means for doing all that needs doing appear to exist within today's body of science.

The foregoing comments on manned space flight are of course applicable only to nearby orbits a moon's distance or so away. In considering the nearest other planets, Mars and Venus, a manned flight, including landing and return, requires a still greater stepup in nature of passenger accommodations and overall weight over the lunar trip, and is thus still farther away from attainment with ICBM hardware alone Still the steps appear clear in the scientific sense, it being largely a matter of choice amongst alternate approaches, and then years of expensive, coordinated engineering effort, as distinct from true scientific research.

There is still another manned space flight possibility that receives discussion and must be listed, namely to the most distant planets of our solar system and even to the nearest stars. Here the distances are so vast and man's life span so relatively short that the hardware and propulsion methods born out of long-range ballistic developments are hopelessly unsuitable. Here, in fact, we need more than inventions. Scientific discoveries are needed in control and conversion of matter and energy so as to make possible steady application of substantial thrust during flights of many years' duration. Specifically, a manned flight to the nearest star would require years of flight, even at near the velocity of light. While we know no laws of science to rule such a voyage out, we also have no such understanding of these same laws as will permit us even to start a design. In fact, no basic physical process is known to us that would enable the flight duration to be less than hundreds of years.

Our discussion so far has emphasized the relationship amongst a number of missile and satellite proposals and other space projects, based on similarity or lack of similarity of hardware and techniques We can also call out some generalizations about whole classes of space weapons systems. For instance, if the altitude of a vehicle is high enough, it encounters negligible drag, and from this standpoint very long flight durations become possible in space. At the same time, if its velocity is high enough in magnitude, and properly oriented in relation to the shape and size of the earth, the vehicle need not fall to earth prematurely because of gravity pull, even though aerodynamic lift is missing. Fortunately, with more or less conventional propellants, and the absence of major aerodynamic resisting forces, high speeds can be attained in space. Speed may be incidental to the real objective in some space-flight missions that emphasize instead long duration of flight. Space offers a new way of obtaining long durations.

Another unifying concept comes about because of the relationship between the size and shape of the earth and the time of passage around it or from point to point on the surface by space vehicles When one nation can set out to inflict decisive damage on another by delivery techniques better measured in minutes than in hours, and in which the distance between launcher and target is a substantial fraction of the earth's circumference, then the military problem obviously forces consideration of the whole earth's surface and a considerable amount of space above it. To carry on warfare with this relationship between distance and time, the military will require of the technician the development of means for observing, communicating with, and physically contacting all parts of the entire surface and the space surrounding it on a minute-to-minute basis. Notice, however, that once an observation post, or a communications relay point, or a vehicle for warhead delivery reaches a distance from the earth of one or of a few earth radii, then little is to be gained and a good deal may be lost in seeking to place these maximum excursions out even farther. After all, an observation point even an infinite distance away sees only one-half of the earth's surface at a time.

An analogy can be made here to an imaginary two-dimensional situation in which we are more accustomed to carrying out our thinking. Suppose the earth's surface were covered entirely by ocean except for a relatively small island populated by two separated groups. We might then imagine a considerable use of the ocean surface near and around the island for numerous missions affecting the internal operations of each nation and war or trade between them. But the need for control of the entire ocean would not be obvious. Now, in three-dimensional space, we have the sun and the moon and the other planets of our solar system. It is understandable that we should want to go out into space, take a closer look at all of these other bodies, make observations, and bring back the information. It is far from clear, however, that control of

earth must necessarily go to that nation which has put more of its resources into escaping from earth's gravitational pull.

Consider, for example, a retaliatory capability for the purpose of deterring aggression. Assume that from our limited resources we choose to assign a certain fraction to such a deterrent capability. If the strategic bombing force is to be a deterrent, then a sufficient portion of the total planned force must be counted on to survive the enemy's surprise blow. Now, such survival can be attained in principle by a number of methods, including dispersal and secrecy as to the location of the retaliatory force, hardening to resist a severe attack no matter how strong, and active defense. The problem is always one of comparing all of these ways on the basis of economics, resources, reliability, readiness, and all of the factors known so well to the military. The use of outer space merely adds additional cubic footage, enormous quantities thereof, to the potential locations of our strategic force. It adds new problems for an enemy seeking to know its location and planning to obliterate it. Technically, we have it as a matter of choice to use a volume that extends from beneath the average surface of this earth out to distant space, to the moon and farther. The more of this total volume we decide to include in our plans, the more costly and complex our weapons system may become. We do not get this additional volume of space for nothing, and it is not evident that resources expended to buy additional volume may not better be used to buy other improvements or guaranties of an inevitable retaliatory capability.

For instance, if our basic technique of retaliatory bombing were characterized by a very small number of warheads to be delievered, we might be inclined to pay a tremendous premium, relatively speaking for the privilege of putting our launching sites at such positions in that volume of space available to us that the possibility of enemy interference with our ability to retaliate would be minimized. But, on the other hand, our retaliatory capabilities might be characterized instead by large numbers, made possible, for example, by developing increasingly simpler and cheaper ICBM's. We might then believe that, despite the relative accessibility of potential launching spaces to the enemy, it would still be highly improbable for him to eliminate enough of this huge force to avert retaliation. Accordingly, we might be inclined to assess the extension of the volume of space available to us as deserving much less out of our overall limited resources.

These and many other considerations deserve high-grade quantitative military-scientific analyses to determine whether space launching sites on the moon or elsewhere constitute the best way to use our budget on behalf of a vital deterrent capability. In any case, certain facts stand out. It is not automatically true that bombing grows better the farther away from which it comes. Things may change so it will some day become obvious that bombing from outer space is the best approach. We must be in a position to exploit a new possibility, and we must therefore assign some of our resources to the problem. However, let us carefully distinguish between an urgent program of experiments, analyses, and early explorations intended to find out an answer and be ready for new requirements, on the one hand, from a crash program to develop a complete system based on the idea that the answer is self-evident.

Of course, what has just been said about strategic bombing and deterrent capabilities is equally true about weather control, communication systems, and the like. In every one of these instances, there are competitive ways of spending the Nation's resources in an attempt to achieve the same ends, and the problem always includes making comparisons. In fact, realistically, the biggest costs of most of these systems are in the ground-based rather than the space-based components. Generally these proposals involve a system of much new, complicated, automatic gear, widespread geographically, with advances required in information transfer, interconnection, and control to make the operation practical. Much of the development, and hence of the planning and comparing, needs to go into these overall system considerations if most space weapons systems being proposed are really to be judged seriously.

A certain general argument needs now to be described. It starts by recognizing that weapons systems involving vehicles in space can be of military value, and, moreover, even if only for scientific data gathering the data strengthen the nation that collects them. Accordingly, it would appear to be of interest to a competitive nation to seek out and destroy any space vehicle of its potential enemy. At least doing all required to make possible clearing space of the other's vehicles should be considered—this even if it means sending up a more costly space follower to be paired off with and be prepared to destroy each entry

into space of the rival. Of course, this game readily leads to more and more complex systems with space-located subsystems of increasing scope and variety, and encompassing more and more of outer space. The problems of detection, interception, data handling, decisionmaking, and communications will eventually involve the introduction of automated operations and man-machine relationships on a new scale. As a technical man, I am inspired by the continuing challenges all these steps and countersteps will present. Here truly we have a limitless candy store. However, the ratio of contribution to security to resources expended could reach a new low. As a citizen I hope it will turn out that inspired handling of international affairs and military strategy can somehow avert that kind of space age. But, if it has to go that way, our present hardware and techniques give us a solid beginning, and we can build on it at a pace limited by the technical and physical resources assigned.

Clearly, planning space weapons systems presents us with a new predicament. We should like to be logical and assess the true military value of a space program. But what good does it do to say that the moon may be an unnecessarily far and otherwise unhandy place from which to launch an attack or to prove with factors to spare that if another nation chooses to direct bombs at us it can be done more cheaply and with greater certainty from bases on earth? Would the United States public be content if the Soviet Union were established with anything whatever on the moon and we were not? Nor can the technical body furnish a sufficiently strong reassurance that the moon and outer space in general are just so much more Siberia. This is because we may indeed find useful new matter or phenomena on the moon, the sun, or the planets, and, so the argument goes, we cannot allow another nation to discover these things ahead of us because they will then be superior in science and, ultimately, will have a superior military capability. It is not that future scientific research is held up by a crucial, bewildering scientific enigma which can only be answered by space flights. The situation is more general.

Here is a region of unknown, and experience shows that whenever we explore the unknown and it becomes known we find additional scientific principles and useful applications.

In this general sense, we again notice that space research should really compete with other forms of research, but it is more than most involved with the problem of psychological warfare. The Russians' sputniks have influenced world affairs. A space experiment has the advantage of being conspicuous. It excites the imagination more than the average quiet research on other aspects of nature closer to earth. It is not that space research is the only glamorous research area. There are others that could well have convinced everyone that Russia's scientific powers had been underestimated. Suppose, for example, that Soviet Russia and not the United States had produced the answer to polio, followed quickly by a universal cure for cancer. In addition to concern over such evidence of possible Soviet superiority in biological and medical sciences, many would quickly point out military implications as well. That is, it might be feared that any nation that knows enough to stop cancer could threaten us with a mortal, new form of biological warfare. On top of this, let us imagine that Soviet science turned up well ahead of us with important new and basic developments in the field of controlled thermonuclear energy. It may be that a given amount of our technical resources assigned to the space field will do more for us in the world public mind in showing our relative standing as a great scientific power than an equal amount of money spent in any other field. If this is true, I trust that the right people are comparing the alternatives and will make the right decisions, because it is not enough to hear from the space engineer in order to decide the issue.

In summary then, we must label the long-range ballistic missile as a vital weapon. Certain orbiting and related space weapons systems are potentially vital and merit top priority even though at the same time deserving of objective comparisons with alternate ways of doing each military mission. As to escape, exploration of outer space, control and patrol of it, and scientific data collection to learn more of the life and phenomena of our solar system—it is harder to prove that these fields are vital to our security. There is a possibility that if another nation leads in these areas and leads sufficiently, it may eventually discover such new science as will cause it to invent weapons systems giving it decisive advantages for control of this earth. Because of this concern, and because of the worldwide psychological effects of any other nation having a superior scientific position, space research and space exploration appear to deserve a large budget, a high priority, and wise planning so that at each stage

of the probing into space good use is made of the knowledge and the hardware the earlier stages have made available to us.

Those who must make the overall decisions will make the best ones, in my opinion, if we distinguish the clearly vital space weapons systems from the intuitive feeling that man must ultimately make a conquest of space. From now on, it is going to be increasingly important to insure that wisdom accompanies imagination. The earth may not be inherited by the nation that first escapes from the earth on a grand scale, but rather by the one that does it just often enough and does a lot of other things besides.

Appendix C

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ICBM: Giant Step into Space

Here for the first time, is an authoritative account of the entire AF long-range ballistic missile program, its relation to past and future developments in terms of management and technical know-how, and an explanation of how it can make the conquest of space a reality

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The long-range ballistic missile program of the United States Air Force represents the largest integrated technical development program ever attempted by this country. It involves a simultaneous extension in practically every phase of the guided missile art. Compared with previous developments, it means higher thrusts, larger weight-to-structure ratios, higher speeds, higher accuracy and greater versatility in guidance and control, higher rates of burning of propellants, higher temperatures and greater expansion of facilities and industry capability in a short time.

The purpose of this article is to discuss, as security restrictions permit, some aspects of the USAF intercontinental ballistic missile (ICBM) and intermediate-range ballistic missile (IRBM) projects. In particular, an effort will be made to relate these developments, in terms of management and organization, as well as scientific-engineering concepts and actual hardware, to past and future developments in the missile field.

The Air Force ICBM program has a decade of background. The decision to broaden the effort and give it top priority was made in recent years, but development began some 10 years ago at Convair Division of General Dynamics Corp. During that period, scientific feasibility and military requirements were in proper harmony in a relatively small program looking to the fairly far-off future. Then changes in both the technical art and military needs combined to dictate an unprecedented effort to obtain the earliest operational capability.

Characteristics of Guided Missile Development

But there is a decade or more of guided missile experience covering a multitude of other projects as well, some of which have become operational. It will probably be helpful to summarize some general characteristics of guided missile development apparent when the accelerated ICBM program was planned, before discussing management and engineering details applying to this specific program.

Of course, it is clear that a program of this type must include a large technical effort to develop and design all the components. And, for such development work to be completed satisfactorily, hardware must be built and tests made that confirm the workings of the entire system. What has been less than completely obvious in some past developments is the extent to which the whole developmental plan must hinge around certain practical factors.

The research and development plan must be based on careful matching of military requirements and the state of the art. The easy approach is to assume, from some "semi-hunch," qualitative considerations, both the military requirements and the supposed state of science and engineering. A more difficult approach, but one which can literally save years in attaining a useful end result, is to recognize that both the military requirements and the technical art are complex issues requiring careful interpretation and the consideration of many parameters on a quantitative basis, with full account of their reciprocal effects. To obtain a real payoff in time and resources, the task must be faced up to by a proper team of military and technical experts brought together for steady and objective influence on the research and development plan.

The picture of a guided missile program in which only one missile is assembled and taken out to launch, with the chief scientist and his sole assistant waiting with high hopes for a confirmation in final flight test through this single definitive trial, is for the comic books, and not for a realistic world. A single or a few shots of a missile, built breadboard fashion by its inventors in a closely supervised model shop, may be a satisfactory approach to illustrate a principle. More often, in guided missile development, the step being taken from the technical standpoint is essentially beyond question as to its scientific basis. The key problem is to so organize the program as to assure the efficient working out of all the engineering details, some in theory and some by experiment; the attainment of reliability through a great deal of testing; and an industry capability to reproduce the results in the quantities required for a military force.

How early production planning can be started is special for each guided missile project. It is a function of the newness and complexity of the engineering and the relative risk of having a delay while production is planned after the development is completed, as against having to re-do production tooling or manufactured components if the late stages of development disclos that substantial engineering design change is needed. However, in any case, it must not be overlooked in the development of a missile that production and operational capability are the real end goals of development.

In the past, reliability considerations have not been in the foreground often enough. Clearly, a complete missile system cannot be very useful in a national emergency if it is likely to fail in some important respect more than a small fraction of the time. But the complete system consists of many major subsystems, including, of course, much more than the vehicle itself, creating further problems.

Suppose we ask for a modest 50 percent chance that the complete system trial will occur without a malfunction of some major subsystem. For simplicity, let's say there are 5 or 6 of these main subsystem elements, with an equal chance that 1 of them will function improperly during flight. Then, to have a 50 percent chance for a completely successful flight, each of these subsystems must be counted on for roughly a 90 percent chance of operating perfectly.

But each of these subsystems itself consists of hundreds of critical components, which must then have an average reliability during flight in the 99.9 percent region, with a failure of only one in a thousand. Even if each of these components is laboratory tested, improved and retested innumerable times, this must be followed by systems testing to determine the interactions of one component on another when working in an ensemble, and then by flight test because of possible reduced reliability owing to environment and unknowns in actual flight that no prior simulation or analysis can dependably reveal.

CANNOT RELY ON FLIGHT TESTS ALONE

Typically, missile flights are measured in minutes. A flight-test program, especially in its earlier stages, reveals only fragments of data for various parts of the complete trajectory. Hundreds of flights may be needed to accumulate a single hour of operating experience. It is apparent that the attainment and the proof of reliability, somewhat different considerations, cannot rely on flight test alone, because of the enormous expense and the relatively small amount of data obtained Wherever possible, all subsystems must be brought to high reliability by ground tests. The complete systems test must be used for that class of problem in which interactions among all parts of the system and the true environment of flight are the added problems.

This does not mean that the first flight test should be delayed until testing on the ground has caused all elements to reach a stage of reliability where nothing remains but these final interactions and environmental problems. Flight testing in its initial stages obviously is carried out to uncover interaction and flight environmental problems as early as possible, even if it is a virtual certainty that the first flight tests will be handicapped by unreliability of components.

Thus, the final ground development of all subsystems and components for the goal of a successful operational flight depends partially on the results of earlier imperfect flights. Complete systems tests, including missile launchings, constitute the only way ultimately to completely confirm the soundness of system design. But the first flight tests are so likely to be plagued by the accumulation of many detailed shortcomings of the whole operation that they might mask a fundamentally wrong system configuration, if such a misconception in design philosophy actually existed.

RELIABILITY AND GOOD DESIGN

The important lessons from the past include the fact that reliability does not come naturally as the result of good design. An engine will not provide a specific thrust just because it is well designed. It must be designed for that specific thrust. And no matter how well designed for 1,000 pounds of thrust, it is not likely to give 100,000 pounds unless so grossly overdesigned as to constitute a poor engineering choice for the original requirement. Similarly, a particular component is not going to give 99.9 percent reliability unless it is designed for that from the beginning, and we are not going to know whether it has that reliability unless we have a planned program to prove it.

Programs of the past have included some that have lacked sufficient hardware to make possible any satisfactory approach to reliability testing. Other programs have been so optimistic as to the number of units of the system that could be used to advantage that they suffer from indigestion, with shops busy making parts whose workings have not been sufficiently well understood and whose test program, both as to technical manpower and facilities, was inadequate to make use of the hardware as a means for finding design weaknesses. Planning the amount of hardware for each stage of the program, from the beginning of component development and reliability checkout through to final systems testing and initial operational capability for military use, is a major factor in setting up and maintaining a good development program for a major missile system.

There is probably no characteristic of major weapon systems programs that has so often in the past been the determining factor in the speed and efficiency of development than the facilities program. The tendency all too often is to fail to include all needed facilities, or to underestimate the lead time required and the technical difficulties of such facilities programs. Major facilities acquisition also involves difficult arrangement-making problems between various Government agencies and between such agencies and industrial contractors. Recognition of the size, scope, and complexity of facilities problems is a prime requirement for the successful execution of a major program.

TENDED TO FOCUS ATTENTION ON BIRD

During part of the decade now behind us, there was a tendency in some missile-development programs to focus attention almost entirely on the bird. In general, there is a myriad of other equipment that must be designed and other problems that must be dealt with to make for a military operation. Checkout equipment, handling and training equipment, organization of operational bases, logistics, and human engineering factors—all are needed to complete the list. The design of this equipment and attention to the array of procedural and other problems that go with a complete weapon system cannot wait until there have been successful demonstrations of the flying subsystem. Obviously, it is not good systems engineering to freeze one part of the system until attention has been given the other parts. In addition, the desire for early operational capability means all parts of the system must be started early.

NATION'S RESOURCES CALLED UPON

From the beginning of the accelerated ICBM program, it was evident that questions of management, philosophy of overall approach and organization would need a special kind of attention. Moreover the total effort, if carried out successfully in a relatively short time, would involve a costly fraction of the Nation's scientific and material resources. The simultaneous advances required for the present program in all aspects of guided missile system art made clear that large facility, hardware and reliability testing programs would be needed. It was obvious that the entire program would have to be widespread geographically and would require contributions by large numbers of organizations. It would also have to be unusually well organized and highly supported on a good management, as well as scientific, base. These operations could not be left to trial-and-error or hit-or-miss experimentation.

Certainly few, if any, programs have had and continue to have the advantage of a deeper study of the relationship between military requirements and technical possibilities. Time, performance, and resources compromises are always necessary in merging a military need with technical and industrial attainment. But in the present instance, it simply has had to be a lot better. Top military and technical minds of the country have been joining to create and maintain research

and development, production and operational plans with the least doubts as to the fundamental soundness and proper timing for each step.

Of course, any program comprising a vast number of interrelated steps cannot be precisely laid out ahead of time. Moreover, some steps must depend on progress or data obtained in earlier ones. But the objective has been to plan a program that will have a minimum chance of hinging upon any greatly speculative technical issue, and, equally important, upon any questionable evaluation as to the ability to carry out development and production as required.

A fundamental part of the plan for the earliest possible attainment of both long- and medium-range ballistic missiles has been to make maximum use of all past developments in technology, as well as all of the Nation's existing facilities. For essentially every important aspect of the overall program, it has been clear that more than one approach is technically and industrially feasible. However, to predict which of these potential approaches would lead to the others timewise is not always possible. Also, the importance of the program requires insurance against errors in human judgment. For both of these reasons, a certain minimum number of parallel approaches was considered essential in most areas.

Step-by-step into space

Range (nautical miles) (optimum trajectory)	Altitude at apogee	Cutoff or escape velocity
	Nautical miles	*Ft./sec.*
200	70	3,000
1,000	350	11,500
5,000	600	22,000
Satellite	(300)	25,000
Moon		35,800
Mars		36,500

But there was still another reason for bringing in two major contractors to cover independently most basic subsystems—namely, the amount of effort needed for detailed design, testing and production planning. This huge workload—the different types of ballistic missiles to be developed, the numbers and kinds of needed facilities, the locations of various industrial organizations with respect to areas suitable for testing subsystems and to long-range testing bases—all made clear that for almost every aspect of the job it would be necessary to bring in more than one top organization to share the load. The division of the work was made among a large number of industrial organizations, Government agencies, universities and private foundations, all selected by the Air Force and assigned to specific program segments on the basis of their experience and their technical, physical and management resources.

HOW MISSILE TEAMS WERE SELECTED

With duties in ground-support equipment, training and handling added to the production effort, and all having to be started prior to the completion of the research and development program, it was seen to be advantageous to select for key development projects those organizations in the Nation capable of continuing through to production and operational equipment support. More specifically, it was felt that team members that would ultimately dominate factory testing of production articles to be delivered to operational units should be the ones to make the first experimental tests on embryo equipment.

Separate teams were set up for 3 missiles, with the 3 aircraft team members (Douglas on Thor (IRBM), Convair on Atlas (ICBM) and the Martin Co. on Titan (ICBM)) given the jobs of physical integration of the subsystems into the missile structures and systems testing. The setting up of these three projects has been an efficient way of combining the need for a certain minimum of backup approaches with the equally important requirement of assuring tight integration of subsystem tasks into a harmonious ensemble to meet military requirements.

The parallel efforts had to represent different approaches, yet had to be complementary and of maximum aid to one another. For instance, the propulsion system for Titan should also work for Atlas; the nose cone of Atlas should be operative on Titan. Further, it was frequently necessary for these programs to utilize common contractors. Thus, with the exception of

the airframe contractors, the IRBM program uses subsystem hardware and contractors from the Atlas and Titan programs. All three programs use common Government facilities to a considerable extent, including common flight-test ranges.

The very size and cost of the whole program exerts a control on the extent to which parallel approaches can be tried. Although every effort was made to plan these programs so as to utilize the existing art, and thus eliminate uncertainty as to success, the boundaries between what is known and unknown in the technical art are being regularly pushed back by supporting research efforts designed deliberately to provide a substantial safety factor for all three projects. Wherever there is any major question as to which approach is the best, this implies that the results from one team's effort should be allowed to benefit the work of the other teams.

All aspects of organization—selection of contractors, distribution of responsibility among them, setting up of teams—were based on the objective of earliest operational capability. However, it was only realistic to recognize that the projects would continually need evaluation and modification so as to minimize any threats to success and to exploit any newly acquired information. Also, no program requiring so many new facilities, from special environmental equipment to elaborately instrumental ranges going out thousands of miles, could be planned initially with such foresight that detailed alterations of plans would never be needed. In fact, to try to hold to such an objetcive could be a great handicap.

COMMUNICATIONS WEB WAS NEEDED

Accordingly, it was seen that the central management organization would not only initially require sufficient scientific and systems engineering strength to work with the military in the creation of the research and development plan, but would also have to be in a position to control any major aspect of the program in the light of what was happening at any given time. A web of communications needed to be set up, converging in one central source competent to evaluate the information and to provide proper direction to all team members. Even the initial relationship between military requirements and the performance specifications would require regular reviews, and modifications to attain an earlier result would always have to be weighed against a competitive method using a later but superior result. Planning, monitoring, and optimum assignment of facilities was seen also to be a major effort for the central management organization.

WOULD HAVE PRIME RESPONSIBILITY

Moreover, in view of the plan to parallel the research and development with production planning and complete operational implementation, it was evident that a large amount of central management's internal activities would have to do with interactions among the technical, operational, and procurement aspects. Above all, it was clear that a systems engineering organization would be required to do systems design and analysis and to exercise prime responsibility for overall performances that meet the military requirements.

The communications problem for so large a program presents a real challenge, and a great deal of attention had to be given to arranging the program's operations so as to minimize this disadvantage. An important compensating factor has been the centralization in one geographic location of the Air Force authority and control, embodied in the Air Force Ballistic Missile Division, ARDC, as the executive agency, and the Ballistic Missile Office, AMC, as the procurement agency, together with the systems engineering and technical direction organization—the guided missile research division of the Ramo-Wooldridge Corp.—in one set of buildings, with higher echelons of Government supporting and decentralizing to this program-management team.

PREVIOUS ART WAS USED

Some general remarks relating the ICBM and IRBM technical problems to those of other missile programs may help to show how advantage was taken of the previous art. Roughly speaking, the counterpart, in the sense of a previous technical step, can generally be found spread over the entire guided missile, aircraft, and electronics art. Thus, a ground radar that had nothing to do with guided missiles in the past furnished the basis for an extension for some of the ICBM system. Something similar can be said with regard to ground digital

computers. Some techniques and components came out of aircraft, others out of short-range ballistic missiles and still others from surface-to-air and even air-to-air missiles.

The illustration on page 41, which shows to scale a few of the trajectory characteristics of ballistic missiles for 3 ranges, taking a 5-to-1 step each time, from 200 to 1,000 to 5,000 nautical miles, suggests that some very substantial differences should exist between short- and long-range missiles. On the other hand, a number of factors do not change very much between very short- and very long-range missiles.

In making the major technical decision, a notable effort was made to bring in the experience of all the leaders of the guided missile and associated art. As an example, for the testing plan, experts from earlier programs either joined the present one or were brought into key discussions. Some believed the best way to move rapidly was to analyze every test completed and to use all the results to make improvements before attempting a next test. Others argued that, without a set of tests that would provide statistical and confirming evidence of faults, no solid progress could be made. Many had experienced their worst problems in the past when they tried to reproduce results and wanted special emphasis on catering to the fabrication and assembly problems from the outset. Others felt substantial redesign could be tolerated. Judgment as to technical risk in skipping steps to save time varied, of course. But we had the assistance of most of the experts and the facts of the past to help us.

To give adequate credit to personnel and organizations who have or are now participating would require a separate article. Suffice it to say that practically every aircraft, electrical and electronics organization, Government laboratory and agency, university and nonprofit foundation, was consulted, and that most are either participating or have furnished data and experiences for consideration.

PAST EXPERIENCE INTERPRETED

All of these past experiences naturally had to be interpreted in the light of our specific problems. Many approaches that looked good on other projects were seen to be less than optimum for this one, because the priority and support of this project made possible even better avenues that would not have been possible elsewhere.

Now let's consider specific technical fields. First, propulsion. The need for large-thrust rocket engines is clear because a long-range ballistic missile of operational usefulness must bring heavy payloads up to a power cutoff velocity of 15,000 to 25,000 f. p. s. However, such rocket engines had been under development for about 10 years by the Air Force at North American's Rocketdyne division for use in both long-range ballistic missiles and long-range strategic missiles of the air-breathing type, in the latter case as boosters.

The propulsion program has since been expanded to include other pioneer organizations, with Aerojet-General as the major added contractor. American Machine and Foundry is a principal contractor for auxiliary power supply.

When the Air Force ICBM program was accelerated, this engine work was seen to provide the best possible basis for extension and rapid reduction to practice. As a matter of fact, components of the ICBM engines provide the propulsion system for IRBM missiles as well, with both the Air Force Thor and the Army Jupiter IRBM using these identical engines from the same production line. Thus the manifold expansion in resources which the ICBM program had earlier placed in motion to accelerate the availability of these large rocket engine components was a major factor in the determination of estimated schedules for the IRBM programs.

For thrust control of the ICBM and IRBM, both as to cutoff and thrust vector orientation, use was made of the background experience of various organizations in the country. In particular, a basis for the swiveling of the rocket engines to control thrust vector orientation was provided by the Air Force's work on the project MX-774 surface-to-surface missile, performed by Convair, and on the Bomarc surface-to-air missile, performed by Boeing, and also by the Navy's Viking program for upper atmosphere research, performed by the Naval Research Laboratory and the Martin Co.

Structure problems with long-range ballistic missiles are severe for several reasons. Keeping structural weight to a minimum is much more critical than it is for most other flight vehicles. In addition, the structure must withstand high accelerations and speeds, and extreme conditions of air density and temperature, and high Mach numbers are reached in regions of substantial air

density and with considerable temperature differences between the outside and the inside of the structure.

The structural problem is somewhat less severe in the case of the IRBM. Of course, it is possible to design a short-range surface-to-surface ballistic missile so that the structural weight is very critical, with the range falling off badly from the design requirement when and if the structure has to be made somewhat heavier because of unanticipated problems. However, as a function of range, it is very much easier with today's art to overdesign rangewise for the shorter range ballistic missiles. As one increases the range to intercontinental proportions, it becomes increasingly more difficult to choose all the other parameters so as to allow for generosity in the assignment of weight to the structure itself

FACES SIMILAR PROBLEM

The problem has considerable similarity to that of the long-range, high-speed airplane, where the designer also reaches a situation where a small difference in structure can make a large difference in performance of the aircraft.

The detailed design of such large, lightweight structures and the physical integration of all components into the structure have been part of the successful operations of aircraft companies for years. It is not surprising that the Air Force has chosen some of the most experienced of these companies to handle the structure and physical integration role.

The guidance and control problem for the ICBM is similar to that for certain surface-to-air missiles, as well as shorter-range surface-to-surface missiles. In a ballistic missile, the problem is to attain the proper vector velocity at the end of a relatively short powered flight path. Whether this is done by measuring the motions of the missile with onboard accelerometers mounted on stabilized platforms, or by the use of radio measurements made from the ground, or by some of both, the problem is similar to that of a surface-to-air missile which must traverse a limited region of space with the proper timing and velocity to intercept its target.

Of course, there is great similarity between long- and short-range ballistic missiles. But one must be careful here in making the extrapolations, because in general the instrumentation errors as seen at the target grow much more rapidly than with range. Also, the distances for communication from ground to missile can be very substantially greater, so that the communication components do not necessarily have the range to permit them to operate with comparable performance, if at all. A gyro carried by the missile has less time to accumulate a drift error in the shorter boost time of an IRBM than is true with an ICBM. In addition, for the same accumulated drift at the end of powered flight, the error is greater at the target for vector range.

COULD BE APPLIED TO IRBM

Thus, certain guidance and control components that were already under development for the ICBM could be readily applied to the IRBM with a relaxation of component performance specifications.

Radar and computer equipment has been an important aspect of the defense program of the military services for many years. Some of these major contractors, including General Electric, Bell Telephone Laboratories, Western Electric, Sperry Rand, and Burroughs, are now engaged on behalf of Thor, Atlas, and Titan.

Other projects have furnished substantial background on precision inertial components. The requirement for low drift in the gyros, for example, arose in previous long-range strategic bombing and navigation work, both for manned bombers and jet-propelled guided missiles. In such past developments, the gyro drift rate had to be kept exceedingly small so that the cumulative effect for the longer flight time would not impair the final result. In the case of the same miss by a ballistic missile and by an aircraft-type missile of intercontinental range, for example, it is the latter that requires the higher accuracy in the sense of freedom from drift, by a factor of more than one order of magnitude.

Of course, gyro drift is not the only, or even the major, source of error. But it could be a major source if we were not in a position to apply available high-grade precision gyros that have been under development for many years for aircraft systems as well as missiles. Fortunately, the same inherent mechanical design features that free these instruments from error also make them very rugged. They do not fall apart under the higher acceleration of the ICBM. Several organizations that have had a decade of successful experience with pre-

cision inertial components and stabilized platform work are now heavily involved in the Thor, Atlas, and Titan programs. Among these are the Instrumentation Laboratory at MIT, AC Spark Plug Division of General Motors, and Arma Division of American Bosch Arma.

To say that the ICBM reentry problem is unrelated to any past developments is an overstatement, of course, but let us take it as a starting point. Initially, we had no experimental results on any missiles or airplanes for the required ICBM conditions. The problem here includes one of high heat rate, but for a short time. Not even meteorites provide us with comparable data, although some useful clues can be obtained from them.

The problem was first attacked with an intensive theoretical exploration of the fundamental processes involved. This effort, one can say with only slight exaggeration, enlisted the combined hypersonics and heat transfer talent of the Nation with background on the problem, through direct involvement with the leading workers in many universities, Government agencies, and industrial organizations, including especially NACA and the California Institute of Technology.

Theoretical extension of such experimental work as existed, mainly for lower Mach number conditions, next suggested experiments to confirm the theories, and these were set up in several organizations. To date, highly significant experimental work has already been accomplished on this program by Avco with large shock tubes and by Lockheed with multistage reentry test vehicles. These experimental results have confirmed the extended theory and provided the basis for reentry vehicle design. "Nose cones" for the vehicle are being developed and produced by General Electric and Avco

Included in the experimental work was a series of multistage test missile launchings (12 perfect flights occurred in succession), from each of which comprehensive and important pioneer data on reentry were obtained.

Of course, all missiles, except perhaps some subsonic ones, encounter the problem of heating, and for some the heat rate is so high as to require major attention. However, the problem can be minimized by proper choice of parameters in the short-range ballistic missiles, for example, and in most surface-to-air and air-to-surface missiles. It is safe to say that use was made of every bit of pertinent experimental data and every applicable formula that could be found as bases for extrapolation to the unprecedented ICBM situation. For the IRBM, the problem is easier, but still much tougher than for missiles in general.

MAKES SPACE CONQUEST POSSIBLE

The relationship of the ICBM to future developments is partially indicated by noting the power cutoff or escape velocities, required for short, medium, and intercontinental ranges, for earth satellites, for reaching the moon and for reaching Mars, indicated in the table on page 41. We see that each velocity requirement differs by a decreasing percentage from the next slower one. The ICBM, with its capability of imparting a high velocity to large payloads, essentially makes space conquest possible. Insofar as propulsion and velocity are concerned, future projects appear to be almost attainable with ICBM hardware merely by reducing the payload somewhat.

As for the accuracy of guidance, something similar can be said. It is easier to hit the moon than to hit a militarily useful target several thousand miles away from the launch point. The ICBM can therefore be considered a major step toward true outer space technology, especially if one limits consideration to unmanned payloads.

Something too often in the background in space technology discussions is the problem of getting from the surface of some planet, say the earth, out to space and getting back down safely through the atmosphere. What happens in empty space, which takes up most of the flight time, may always be less important from the engineering standpoint than what happens in getting up through the atmosphere to the necessary escape velocity and in getting back down. In these respects, the ICBM is solving a major fraction of space technology problems for unmanned instrumented flights. This would not be the case if the ICBM payload were small for there is a great difference in difficulty and in complexity of task as a function of size of payload. The ICBM payload is large enough to cross over into the region of maximum interest.

Another future step increasing payload requirements even more would be to have human passengers carried through distant space, especially in relatively short times. Because of the passengers and all their equipment, and also because of the indirect problems associated with the length of time of such flights, the increase in payload probably will be one order of magnitude over the ICBM.

Furthermore, because ICBM accelerations are much too high for human passengers, the large ICBM engines would have to be controlled and throttled in a different fashion.

MAY MAKE FOR FASTER PROGRESS

If we seek space conquest for scientific, commercial, or military purposes—whether for world TV relays, weather prediction, or cosmic ray or other physical measurements—certainly this can be done earlier and probably more economically with unmanned, instrumental vehicles. If at present we concentrate on instrumented space vehicles, instead of on those carrying passengers, we may conceivably make much faster progress in space technology. The coming space age may largely deserve to be an instrument-passenger kind of era. The space age may come faster if it is so recognized.

The foregoing remarks about the future, based on ICBM experience and accomplishments, have touched mainly on technical state-of-the-art advances. What of management and organization? Does the present kind of unique management setup offer a solution to the problems of how to get large systems engineered and directed?

The writer can only give his own opinions. One of them is that "there is more than one way to skin a cat." Not every big project would appear to need a special management-systems-engineering group such as exists for the AF ballistic missile programs. More often, the systems engineering task can be effectively carried out by one of the major industrial contractors engaged in producing part of the system, perhaps an aircraft manufacturer if the system hinges on aeronautical or structural aspects, or an electronics manufacturer if transfer and control of information are the critical aspects. At other times, the answer may be a group of associate contractors, with the systems engineering held by the Government.

For the present management-technical-direction scheme to be appropriate on some future project, some of the exceptional conditions that brought the present one about would have to reoccur. These would include a crash effort requiring many large, competitive industrial firms; exceedingly broad advances in the technical art, radical change in military operational techniques brought about by the new system, overlapping of development, production, and operational preparation; urgency justifying high priority in channeling of resources; and major, widespread, and novel Government facilities. Under these unusual circumstances, the present AF arrangement, combining under one roof a capability for overall management, procurement, systems engineering, and technical direction, for visibility and evaluation of all progress, for analysis of performance versus requirements and for assessing technical risk versus funds and urgency, would appear a good way to do the job.

The cost of systems engineering and technical direction on the ICBM and IRBM programs is about 2 percent of total costs. It will be an even smaller percentage when later production costs are added after the systems engineering is finished. Whatever arrangement is adopted for any future project, the quality of the systems engineering and the objectivity and competence of overall technical direction obviously can have an effect on the result far beyond the cost of these tasks.

Evidently the organization of the direction of any important project merits considerable thought.

The CHAIRMAN. Mr. O'Brien, do you have any questions?

Mr. O'BRIEN. Does not what you have said spell out in the long run the establishment of a Cabinet post of Secretary of Science to provide the adequate umbrella you have in mind for all of these scientific endeavors?

Dr. RAMO. I think it well might.

Mr. O'BRIEN. I might say from the testimony we have had I think the military people did a terrific job and filled a vacuum which might not have otherwise been filled and I do not think they overlooked the basic research at all; it is a question of degree, but there is a possibility that the Defense Department might from time to time, because of the urgency of its own responsibilities, subordinate that which could lead quickly to the peaceful uses of the unknowns.

Dr. Ramo. I think that is exactly right, yes.

Mr. O'Brien. Would it be your idea that for the time being we might create some agency such as that in the bill, or give the power to some existing agency and then in the long run work toward the establishment of that overall office with a general recognition of science in the peacetime field, as well as the military?

Mr. Ramo. And may I say that again in my own words?

Mr. O'Brien. Yes, I wish you would.

Mr. Ramo. I believe that looking back and looking ahead that we have evidenced in the past and we have reason to fear in the future that as a Nation we may not do enough pure basic research that is well removed from any immediate military capability.

Mr. O'Brien. That is what I had in mind.

Dr. Ramo. We must find means for assuring larger research programs.

On the other hand, we must be certain, in the process, that we do not say to that part of the Government which has responsibility for the military that it is precluded from doing one or another type of research whenever it feels that that research is already pertinent to a military capability.

Mr. O'Brien. Under the Secretary of Science again, you might have a situation where the military was engaged in something that was purely military, but in the process would uncover something that could lead in the long run to a major peacetime development.

Dr. Ramo. Exactly.

Mr. O'Brien. That would be the point where the Secretary of Science could step in and see that little idea did not die aborning and was given a chance to develop more rapidly than it might if it was just riding along with a major military project.

Dr. Ramo. That is right. I would expect it would be more probable, however, that this pure research organization, be it a separate department involving a Cabinet post or not, would recognize that its entire reason for existence was to search into the unknown without concern as to whether there is or is not a military possibility.

Mr. O'Brien. We have had mentioned here a number of peacetime developments which are also tied in with the military. I do not know where I picked this up, but someone stated that if we arrived at the point at which we were aiming it might be possible one day to place a caravan of drone vehicles in the sky over New York City and deliver the cargo 20 minutes later in London.

Am I going too far, or is that feasible within the framework of our present speculations?

Dr. Ramo. That is feasible, from the standpoint of our understanding of physics. More than that it is feasible from the standpoint of engineering, it is just around the corner.

The Chairman. Mr. Natcher.

Mr. Natcher. Dr. Ramo, as I understand your statement, you recognize the importance of the problem before this committee, but you believe we should proceed in a careful and cautious manner recognizing the important problems from a military standpoint and go further; is that correct?

Dr. Ramo. I think that is correct. Your choice of wording suggests to me that I ought to again try to restate what you have said in my own words.

I think in the process of recognizing the need for more space research we should not inadvertently create another type of rivalry—which is the kind of rivalry that the proposed Defense Department reorganization is trying to eliminate—between the Defense Department, engaged for valid reasons in carrying out major space programs, and a new agency, which for equally valid but somewhat different reasons, is carrying out virtually the same programs.

This could happen if we are not careful in the way we set this up.

Mr. NATCHER. Doctor, have you had a chance to examine the bill which is before the committee?

Dr. RAMO. Yes, I have.

Mr. NATCHER. Are you in favor of an agency controlled by a civilian group, that is not military control? How do you feel about that?

Dr. RAMO. I feel that if the agency's prime work is to do pure research without a clear military objective, that it should be controlled by civilians.

Mr. NATCHER. Thank you.

The CHAIRMAN. Are there any further questions?

Mr. Sisk.

Mr. SISK. Doctor, would you recommend the retention of ARPA then, and a liaison between ARPA and the new agency be set up?

Dr. RAMO. I would very definitely recommend the retainment in the Department of Defense of the necessary capability to direct, plan, and execute programs in space.

Mr. SISK. Either ARPA or something similar?

Dr. RAMO. Either ARPA or something similar.

The reason I avoided saying ARPA is that I am aware of the fact that there are recommendations for Defense Department reorganization in which I do not claim expertness.

The CHAIRMAN. Are there any further questions?

Mr. McDonough.

Mr. McDONOUGH. Dr. Ramo, do you see a relationship in a Secretary of Science on the Cabinet level, a relationship with and a cooperation with space and nuclear development?

Mr. RAMO. I think there is a relationship. I cannot claim to have expertness in the sense of how they are related as to common agency and common direction, but I would say that in considering a separate Department of Science, the Atomic Energy Commission, this agency presently being considered for space, the National Science Foundation, and perhaps certain other organizations should be considered as candidates for that department.

Mr. McDONOUGH. That would, of course, make it more civilian than military for the reason that the National Academy of Science and the National Institute of Science and Atomic Energy is devoted principally more to civilian development than it is to military.

Dr. RAMO. Yes, I think that is true. But on the other hand, I emphasize that the functions of that group should be to do pure research as much as possible, as distinct from the clear military developments.

Mr. McDONOUGH. How far should they go in research? Merely be an agency of government to provide difficult things for private industry that private industry could not possibly do on its own, finance on its own?

Dr. RAMO. I think there has to be a combination here. I think it is very difficult to get a black and white rule.

Largely, of course, this agency would take on that class of project which requires such financing and is so speculative that it is unrealistic to expect private industry to take on the job.

For example, I mentioned that there are clear indications that improved worldwide communications for the future would involve satellites. I think that indication has existed for some years and has been a topic of conversation within the electronics industry.

Yet I think it is unrealistic to expect the broadcasting companies to undertake a multibillion dollar job of developing everything from the boosters through to payloads and all of the myriad ground equipment in order to bring about worldwide TV.

So there are some projects that just by their scale and their cost require or appear to me to require a Government sponsorship.

Mr. McDONOUGH. The major things for civilian development would be communications, weather predicting, and transportation?

Dr. RAMO. Yes. In the space field. I think you can count on private industry to go after those things that have not only a near-term, but even a long-term potential.

There is a way of the whole idea paying off with our particular way of life in this country. But if it gets too big, or too long range, or too speculative, then I think we need Government support.

The CHAIRMAN. Are there any further questions on the Republican side?

Mr. Fulton.

Mr. FULTON. How big a budget would you have for the Federal Government to spend annually on basic research for civilian purposes for outer space?

Dr. RAMO. Since you recall that I am making the assumption that there would be very large military programs involving billions of dollars a year, and a great deal of coordination, in that case the pure research, as distinguished from the military, in my opinion is less than the billion-dollar level and is in the hundreds of millions.

I am not able really to say, to tie it down any closer than that. Tens of billions is too large; 100 million is too small, but I think a billion is not required if proper use is made of the military development.

Mr. FULTON. I was just asking to get the general magnitude of your thinking.

As the law stands, in order to leave this country, you have to get a passport. The question then arises, should anyone who is a citizen of the United States be able to go into outer space without hindrance or without Government approval?

Dr. RAMO. The best thing I can do is say that that is a type of question on which I regard myself as quite incompetent.

Mr. FULTON. The question is should any person, group of persons, or business, have the right on their own to go into outer space or put objects into outer space, or should the Government have a law to control the use of outer space for each of our citizens or residents?

Dr. RAMO. There is a partial answer that I think I can give that rests on some technical facts about which I have some competence.

Mr. FULTON. Does freedom of enterprise go into outer space? should we leave it open for business to do it?

Dr. RAMO. Clearly in my opinion we cannot prevent other nations from doing it. What we can prevent is what our own citizens do.

I think it is clear that we could set up laws and enforce them.

Mr. FULTON. Not prevent, it is control. Should there be Government control, or should there be freedom of business enterprise by individuals to do what they want in outer space?

Dr. RAMO. If we put aside the question——

Mr. FULTON. Put a statement in the record. You can think it out.

Dr. RAMO. I might not properly appreciate your question, but there are dangers involved to the civilian population.

Mr. FULTON. All right, should the teen-agers in your neighborhood be able to put a missile into space?

Dr. RAMO. There is no question but what we shall have to have laws to control what our citizens do.

Mr. FULTON. Should the teen-agers in your neighborhood have a right to put a missile into space by their joint action?

Dr. RAMO. Definitely, no.

Mr. FULTON. Should businessmen who decide that they want to do certain things for profit be able to put advertising signs in outer space or over and around us, whether we want them to or not?

Dr. RAMO. I am quite confident we shall have to set up controls for a number of reasons, the most urgent one of which is, of course, safety.

Mr. FULTON. Then you have heard of the electronic and radio system where the beeps are so fast they invade your consciousness without your knowing it and imprint advertising slogans on your brain. Should we permit that?

Dr. RAMO. I would be very much against that, personally.

Mr. FULTON. You would not permit, then, any business promotion in outer space; is that right, in your business?

Dr. RAMO. I think that what I would permit is application to the Government and some type of Government control.

In other words, a technique of licensing. Perhaps that is a way of saying it.

I would not assume at the outset in considering this question that private business should be kept by law from putting private articles into outer space, but I think it should be under Government control that they do it.

Mr. FULTON. I was inquiring to see whether there was a ceiling or route on free enterprise in this country or whether is goes up as high as property ownership does.

According to you, it does not.

Dr. RAMO. I do not know of any altitude ceiling that I can think of as a basis for establishing control. I think control is one thing, but an absolute ceiling is another.

Mr. FULTON. But where should the control begin? At what level should the business begin to come under government control?

Dr. RAMO. It may be a question of extending the rules that we already have for aircraft.

Mr. FULTON. Thank you very much.

That is all, Mr. Chairman.

The CHAIRMAN. Are there any further questions?

Mr. Metcalf, I overlooked you. Did you want to ask some questions?

Mr. METCALF. I was not overlooked, Mr. Chairman. I do have a question, if I may.

Your question was "Can NACA be the proper vehicle," and you said it would be a complete vehicle. Does that shut out some of the other means of taking care of civilian organizations such as the commission and these things discussed today?

Dr. RAMO. When I asked that question myself and answered it, I was recognizing that there was already a discussion of the NACA's being converted and enhanced to become the new agency.

I thought it might be well to put in a comment as to the dealings which some of us have had with NACA over the years. It has impressed us as having done such a job both as to quality and as to the nature of its duties that it was suitable. I was merely saying that it seemed to be a logical candidate.

No, I do not rule out other ways of arranging for the new space agency.

The CHAIRMAN. Mr. Feldman?

Mr. FELDMAN. What direct military value do you see now in putting a man on the moon?

Dr. RAMO. I am afraid this has to be a long story.

Mr. FELDMAN. Can you make it brief?

Dr. RAMO. I can see no direct military value in putting a man on the moon today except as an indirect way of arriving in the most effective way possible at the capability of putting a man where we want to put him in outer space.

Since in complex military weapons systems in the future one of our races with Russia is the ability to design what we need to design in the way of a combination of men and machines, we would not want to be in the position of having an inhibition or rule which said one component, man's brain (which is the equivalent of 10 billion electron tubes) cannot be put in certain parts of the system in which we wish to work while the Russians can put man wherever they choose.

Our inventors of military weapons systems would then be handicapped as compared with theirs. But to put a man on the moon for a very specific purpose, such as, for example, to drop bombs on us, that, to me, is not a valid reason as of today.

Mr. FELDMAN. What is the most ambitious project which can be done with the ICBM booster rockets?

Dr. RAMO. I can give you examples. With a natural extension—which means to replace the payload, the warhead, on top with straightforwardly designed other apparatus—we could put instrumentation around Mars so as to make some preliminary investigations of Mars close up. That is an example of an ambitious, fairly spectacular achievement and one extremely interesting to science.

Mr. FELDMAN. Do you see any direct military value to a million-pound-thrust rocket?

Dr. RAMO. In connection with putting man up where we want to put him in space, in accordance with my previous comments.

The CHAIRMAN. Thank you very much, Doctor, for appearing and giving us the benefit of your knowledge.

Will you put Mr. Donovan's full name in the record, too, please?

Mr. Donovan, have you any observations?

STATEMENT OF ALLEN F. DONOVAN,[14] VICE PRESIDENT AND DIRECTOR, AERONAUTICS LABORATORY, SPACE TECHNOLOGY LABORATORIES, A DIVISION OF THE RAMO-WOOLDRIDGE CORP., LOS ANGELES, CALIF.

Mr. DONOVAN. I am Allen F. Donovan. I am the vice president and director of the aeronautics laboratory, of Space Technology Laboratories.

The CHAIRMAN. Do you have any observations you want to make?

Mr. DONOVAN. I think Dr. Ramo has covered most of the points that I would. I might perhaps enlarge on a few items which I think would be of interest to the committee, particularly those related to the problems of getting into space.

I would like to point out that we are about to have, really already have in operation the first spacecraft. By spacecraft I mean machines capable of leaving the earth, going into space, and landing either back on earth, or on some other body in space.

Mr. KEATING. Manned or unmanned?

Mr. DONOVAN. Either one. If it were a spaceship it might imply manned. Spacecraft, as I use it, might mean manned or unmanned vehicles.

The CHAIRMAN. Can that be regulated from the earth?

Mr. DONOVAN. It could be either regulated from the earth, or controlled in certain cases by men on board.

Mr. McDONOUGH. You say this is the first. Do you mean this is a reality now?

Mr. DONOVAN. I mean we are about to get intercontinental ballistic missiles (ICBM's) which have a flight time of 30 minutes, of which 25 minutes is in space, hence they are really spacecraft. We already have intermediate range ballistic missiles (IRBM's) which spend over 10 minutes in space.

At the speeds they reach they are at almost 90 percent of the speed required to go into orbit or to satellite. When you extrapolate what can be done with a vehicle which is already up to 90 percent of the speed required to get into orbit, you find its capabilities are quite remarkable. The ICBM's reach two-thirds of the speed needed to escape from the earth's gravitational field and go to the moon or, alternatively, to travel to the planets Mars or Venus. The speed achieved, I would like to point out, is approximately 16,000 miles per hour, or nearly 10 times the speed record of the X–2 airplane.

We are making a tremendous advance in our ability to reach high speeds. To give you an idea of what this means, I think we can point out the very remarkable achievement of the Army in using the

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Redstone, a missile which was capable of reaching only a little over a quarter of the speed to get into orbit, or about 5,000 miles per hour. Yet, by putting smaller stages on top of it, they were able to push a small payload up to satellite speed of 18,000 miles per hour. If we increase ICBM speeds by the same percentage, we have more than enough velocity to go to Mars and back.

Therefore, with an ICBM which is capable of getting almost to the speed needed to orbit by itself, we can do many space missions by putting additional stages on top of it. It can be used very effectively for both military and civilian space objectives.

I will point out that on any particular flight of these spacecraft it is going to be difficult to determine which objectives it is being used for. Some objectives will have military applications; some will have civilian applications. It might in one particular flight be 60 percent military, 40 percent civilian. It makes no difference which it is as far as the spacecraft is concerned. It is the same basic machine.

The same is true of aircraft. The design for General LeMay's tankers is now being converted into the Boeing jet airliner.

Therefore again in space you need only one basic set of spacecraft in order to accomplish both military and civilian space missions.

Now, if we take the ICBM's or the IRBM's and add to them the 10 to 30 percent of additional pieces that would make up the upper stages, it will be found that we can make some very remarkable space trips. Some of these possibilities have already been reported to Congress. For example, a man could be put into orbit and brought back to earth, and an ICBM with upper stages could accomplish a manned trip around the moon and back to earth. Sizeable payloads could be landed on Mars and Venus and this can be done at a modest cost relative to that for the basic ballistic missiles program, because the big part of the total spacecraft, the ICBM, is already in flight test.

To give an analogy, we are a little bit like the farmer who has bought a tractor in order to haul explosives, but has neglected, however, to buy a plow, a mowing machine, a hayloader, or any of the other cheaper attachments that will really make his tractor effective.

The analogue is not perfect in that the ICBM pushes, whereas the tractor pulls. However, the ICBM is a large basic power unit that can get sizeable upper stages and payloads up out of the basic atmosphere and up nearly to the velocity where they become satellites.

On top of the ICBM's, then you put the other stages which enable you to gain additional velocity. With these smaller upper stages you use higher energy propellents, which you can afford to use in these smaller units, and thereby gain very high velocities.

Once you do these things, you open the way to very remarkable possibilities. For example, you can put telescopes into space, where they would not be hindered by trying to see through the earth's dense atmosphere. One expert in spectographic studies of the sun has told me that such space spectographs might permit learning about suspected heavy element thermonuclear reactions in the sun, and that this knowledge could result in remarkable advances in both the military and civilian uses of thermonuclear power.

Mr. McDonough. Would he not run into the problem of getting into such enormous heat that the whole thing would burn up?

Mr. Donovan. No, we think we know how to solve all such problems, how to put the vehicle out into space and bring the crew back safely, and how to do it in a manner such that if thrust is lost any-

where from the initial takeoff to burnout of the final stage, the crew can return safely to earth. That is, the crew can escape at any point in the flight starting from the launch time.

Even at the time of launching, the crew would have an ejection mechanism so that if the booster rocket fails in the launching, they could catapult themselves up and parachute down safely.

Mr. McDONOUGH. What you have just said is that the initial unit, the initial thrust power unit, is the big problem.

Mr. DONOVAN. This is true. The ICBM is such a unit and costs the big money. You have already appropriated it and we at the Ramo-Wooldridge Space Technology Laboratories are assisting the Air Force in seeing that the money is spent to develop ICBM's as rapidly and efficiently as possible.

Mr. McDONOUGH. That is the biggest problem, that once you have the big power unit that can get away from the drag of the atmosphere and the terrestrial gravity of the earth, from there on it is not so much of a problem.

Mr. DONOVAN. It is much easier from there on. It does not take nearly as extensive developments to provide upper stages for many significant objectives.

Now, it gets harder if you want to put a man on the moon and bring him back. For that we need more thrust than we will have in the ICBM's. Also, I believe we will need more thrust for military purposes. I cannot outline these purposes clearly, but I can say that there is certainly at least as much justification now for a million or two million pound thrust rocket engine for military spacecraft as there was, say, in 1952, before the thermonuclear breakthrough, for engines the size being used in ICBM's.

Mr. McDONOUGH. Let me follow you from this point. You have this large power unit for the initial thrust and you have used 2 or 3 stages of additional thrust beyond that.

You have the man into space and you want to transmit him from that point, the highest point you have shot him at the third stage, to a planet, we will say, what power unit do you have on the satellite to transmit him there and bring him back?

Mr. DONOVAN. We cannot with the ICBM's take a man to another planet and bring him back. We can take significant payloads which will be able to radio back important information. We cannot take a man to another planet or even to the moon and back without another step upward in thrust.

We can take a man around the moon and bring him back into the earth's atmosphere, I believe, and land him safely, enabling him to see the back side of the moon. That is considerably easier. It is no harder to go around the moon than it is to hit it from the propulsion standpoint.

It is a little harder from the guidance and steering standpoint.

Mr. McDONOUGH. You have the difference from the last thrust of the rocket, you have the satellite then, we will say, at 50,000 miles away from the earth. You still have 200,000 miles to go to get into the orbit of the moon.

Dr. RAMO. But he is coasting.

Mr. McDONOUGH. You coast?

Mr. DONOVAN. You accelerate very quickly to the speed required to go to the moon. You reach this speed at an altitude of only about 500

miles. You then coast. You coast for 2 days, and during this period you slow down.

The moon is up here. After 2 days you get to the point of balance between the gravitational pull of the moon and the earth. At that time you would have slowed down to where you would be going only about 500 miles an hour.

Mr. McDONOUGH. Now you are coming into the gravity of the moon?

Mr. DONOVAN. Then, if you are going to go around the moon, you speed up as you go towards the moon, you pass the moon going maybe 2,000 miles an hour at a reasonable distance. The gravitational pull pulls you around the moon, curves you back towards earth, and you come back tangentially into the earth's atmosphere, decelerating in it, slowing down and finally landing safely on the surface of the earth. While I can say here that these things can be done, I would have to give you the details in closed session.

Mr. KEATING. I would like to hear him in closed session.

Mr. McDONOUGH. Now this is not just Buck Rogers, this is reality.

Mr. DONOVAN. This has been presented to Dr. Killian, Secretary Douglas, General White, and numerous people throughout the Air Force.

Mr. KEATING. What temperature are you going to run into within 2,000 miles of the moon, 200 degrees below zero?

Mr. DONOVAN. Your temperatures will be about the same as in the satellites circling the earth, which are quite moderate.

Mr. KEATING. What is the outside temperature in the satellites circling the earth?

Mr. DONOVAN. The inside one they are holding around 70 degrees. The outside temperature is not going up very much.

Mr. KEATING. But it is pretty low?

Mr. DONOVAN. No, because the sun hits it and keeps it warm on one side.

Mr. KEATING. I thought I read where it was down to 100 degrees below zero.

Mr. DONOVAN. The tendency is to go down on the side away from the sun and up on the other side. By properly arranging your surfaces and providing internal circulation you can maintain the temperature you desire.

Mr. KEATING. Dr. von Braun when he was here in the opening of the committee said that within a year he could send a man into a satellite within 150 or 200 miles into the atmosphere. You are saying that he can go beyond that and circle the moon and come back.

Mr. DONOVAN. I think Dr. von Braun said he could send a man 150 to 200 miles straight up within a year, as I remember, and bring him back down. Dr. von Braun has usually been quite able to carry out the experiments that he has said he could do, so I believe he probably could do this one. I think the question is whether the value of the information so obtained is worth risking a man's life.

Mr. KEATING. What about the effect of the intense gravitational pull on the man in such a satellite or capsule? How many gravities would he have to sustain in going up?

Mr. DONOVAN. Again I would have to give that in closed session.

The CHAIRMAN. Are there any further questions?

Mr. O'BRIEN. May I ask one question, Mr. Chairman?

The CHAIRMAN. Certainly.

Mr. O'BRIEN. Mr. Donovan, I know it is a fact that you are highly regarded in scientific circles. Do you believe that our educational system as now constituted is capable of producing scientific knowledge that we require?

Mr. DONOVAN. I am concerned that our educational system as it has been operated is not putting sufficient emphasis on science, nor enough on discipline and on taking advantage of the capabilities of the exceptional student. I see some rather strong trends toward improvement recently.

The CHAIRMAN. Any further questions?

Mr. FULTON. Mr. Chairman, I have one question.

A question comes up when you have inferentially said that the propellents now used for an instrument like the Vanguard are buried in stages because of the cost, so if you start on the first level with oxidation type propellents and the second type with hypergolic type propellent and the third stage with smaller solid propellents, pressurized, suppose you started the first stage regardless of cost with the third stage fuel, how small an instrument or vehicle would you then have?

It seemed to me when I was at Cape Canaveral there was such an elephant body and such a small rabbit head for the orbiting satellite. How small a vehicle would you get so that you would not have to have one 60 feet high with a structure like a stone wall?

Mr. DONOVAN. Again, as to the possibilities of size reduction, I would have to go into classified information.

Mr. FULTON. Could you use the third stage without first or second stages, if you put enough power in the one?

Mr. DONOVAN. I think it is obvious if you put enough power in. Whether you could get enough with particular sizes and propellents is more questionable.

Mr. FULTON. That is all.

The CHAIRMAN. Thank you very much, Mr. Donovan, and also again to you, Dr. Ramo.

By the way, you can edit your remarks. I hope you will elaborate and express any other views you might have overlooked or clarify any views you have expressed.

Dr. RAMO. Thank you, Mr. Chairman.

The CHAIRMAN. The next witness is Dr. Arthur Kantrowitz, director, Avco Research Laboratory, Everett, Mass.

Doctor, you have been patient. We appreciate it very, very much. We shall be very glad to hear from you.

STATEMENT OF DR. ARTHUR KANTROWITZ,[15] DIRECTOR, AVCO RESEARCH LABORATORY, EVERETT, MASS.

Dr. KANTROWITZ. Thank you, Mr. Chairman.

I would like to begin by giving my prepared statement and some ideas that I would like to bring before you in connection with the

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space program. I want to say at the outset that I am no expert in the administration of these large scale programs, so I do not pretend to give you any detailed suggestion but I just want to call one item to your attention.

Mr. McDonough. Feel right at ease. We are not experts either.

Dr. Kantrowitz. Thank you.

ADMINISTRATIVE ORGANIZATION FOR SPACE FLIGHT

In order to keep up with or to surpass the Russians we must build a spirit of adventure into our administration of the space program. In other words, our administrative system must make it possible for our native spirit of adventure to express itself.

The closest analogy to what we have to do is to be found in the inventive process—as it has operated in the past. What I would like to outline is the way great progressive inventions have been made, and to see if something like this couldn't be set up in the space business. Individual initiatives has worked beautifully where only small resources were required to make a daring experiment or an important invention. In the past great experiments and inventions—those that have profoundly changed our thinking and our lives—could be done by people who had the courage to risk their time and effort on ideas which were not yet generally accepted.

A good example and one close to our present problem is furnished by the enthusiasts who pioneered in aviation. The general scientific opinion at the time was that manned flight was not yet possible. This was illustrated by an article written by the distinguished American astronomer Simon Newcomb who, as late as 1906, wrote an article proving that manned flight was not feasible by the application of scientific principles known at that time. Fortunately, however, this opinion did not stop the enthusiasts from trying out their ideas.

Consider, however, the situation regarding manned space flight. The cost of a manned satellite program will be a substantial fraction of $100 million. It is clear that this pioneering experiment must be Government supported. Consider now the conflict between the traditional operation of our Government by majority rule and the necessity for allowing our enthusiasts the opportunity to advance faster than the general opinion of scientists think possible.

Consider also the tremendous difficulty which faces our Government in distinguishing between the rare enthusiast who is capable of great progress and the technically irresponsible who do their best to imitate these invaluable people. I should like to propose the following philosophy—that the delegation of authority to lead large-scale experiments be made in a manner analogous to the technique employed in the organization of an adventurous business enterprise. That the substitute for capital, in this case, should be the reputation of scientists who are willing to devote themselves to the project in question. In this way, we can achieve the closest identity between authority and responsibility.

Consider, on the other hand, the way that our current administrative decisions concerning great projects are made by scientific advisory committees made up of distinguished scientists. The membership of these committees cannot, remembering their judicial role, emphasize individuals who have an enthusiasm for the project in question. They, therefore, in their objectivity, record merely the general climate of

thinking at the moment and tend to recommend the adoption of unadventurous policies.

The plan I would propose would restrict the activities of such scientific committees to the evaluation of the reputation of those scientists and engineers who are willing and anxious to devote themselves and to pledge their reputations to the achievement of special projects. These scientific committees would thus serve essentially to establish the "credit rating" of the backers of a project. Note that these backers must be willing to commit their time and reputation to the success of a project, and not just offer their judgment that it is a good or bad idea.

I submit that this type of procedure would give us a far closer coincidence of responsibility and authority than we now have. The formulation of a bold administrative policy in areas of adventurous and expensive research will buy us the speed which is desperately necessary for survival in our time.

I want to depart from my written statement to tell you briefly about an experience of my own in this regard.

Three years ago when the reentry problem first became prominent, it was thought that there were no methods of duplicating in the laboratory the conditions that would be faced by an ICBM during reentry. I had been doing some basic research which involved the creation of just such conditions in the laboratory. It was, however, considered that the instrument which I used, the shock tube, was not yet ready for application to provide the data needed by the ICBM. However, it was possible to convince the ballistic missile division of the Air Force and the Ramo-Wooldridge Corp. that they should take a chance on the possibility that we could do this in the laboratory. They took such a chance and it worked.

I have made the previous statement in the hope that the opportunity for people to do things which are beyond what a judicial committee could guarantee are feasible, that this opportunity must somehow be incorporated into your thinking on this new bill.

MANNED SPACE FLIGHT

What has to be done before we can achieve manned space flight? The first problem is the launching. The launching of a vehicle large enough to carry a man obviously requires very powerful rockets and requires that these rockets be well guided. Thus, our ability to launch a manned satellite into orbit is closely related to our ICBM capabilities. We have been and will continue to devote great effort to achieving ICBM capabilities soon. The country is thus heavily committed to the development of large, reliable rockets with accurate guidance systems. Dr. Ramo can inform the Congress on our success to date in this vital development. It will therefore be interesting to delineate the other problems which must be solved before manned space flight can be achieved.

The first group of problems are the physiological ones which have been under investigation by the Air Force and Navy aero-medical services. There are the accelerations which man must experience in launching which may be as much as 10 times gravity (10 g's). There is a good deal of experience to indicate that a man suitably positioned can take this. When he is out in space he will be weightless. This condition is one which unfortunately cannot be duplicated on earth

for more than a short time. Authorities on this subject, however, do not believe that this will be an insurmountable problem.

There are unusual radiations to be met in space (primary cosmic rays, solar X-rays, etc.) from which we are ordinarily protected by our atmosphere. The evidence is, however, that a very thin metal skin will protect a man against these radiations other than cosmic rays. The consensus of professional opinion is that cosmic radiation hazard will probably not be a severe risk for space flights of a few days.

The problems connected with food, water, oxygen supply, and waste disposal do not seem particularly difficult. There is weight allowance required of the order of 10 pounds a day for supporting a man in these 3 requirements. Lightweight and simple air conditioning and communications equipment, power supply, and other necessities are within the present art. Thus the sustenance of a man in flights of a few days' duration would not involve any great supply weights.

Next, there is the well-known possibility of meteoritic impact, and there seems to be a considerable likelihood that impacts by microscopic meteorites will have to be expected. Protection against these can again be achieved with a thin outer skin. It is known that impact with large meteorites is a rare phenomenon. This is a risk which will have to be taken; however, it will probably not be greater than that involved in driving home from the landing point.

I should like to say that none of these problems seem at the present moment to interfere in any serious way with the capabilities of space flight. There is the problem of weightlessness, which is somewhat unknown at the moment, but the best medical authority seems to be that this also will not interfere with space flight.

Granting then that we have the ICBM as a working and reliable device——

Mr. McDONOUGH. Before you get off weightlessness, have we had any experiments with a human being in a weightless condition?

Dr. KANTROWITZ. Not for any great length of time, only for periods of a minute or 90 seconds.

Mr. McDONOUGH. Why have you not conducted it for a longer period?

Dr. KANTROWITZ. Because we don't know how to do that very easily.

Mr. McDONOUGH. In weightlessness is it not a mental problem and a physical problem? Have there been any experiments to prove what effect it has on a man mentally?

Dr. KANTROWITZ. Not that I know about except for these very short time experiments lasting only, as I say, something of the order of 30 to 40 seconds.

Mr. McDONOUGH. Maybe the information is classified?

Dr. KANTROWITZ. No. But the advice that I have received from the space medical people give me the impression that they are not seriously worried about this problem and that it should not impede our efforts to go out and do this job.

The problem of decelerating a man out of a satellite orbit and returning him safely to earth is probably the most difficult part of manned space flight apart from those elements related directly to the ICBM program (launching and guidance). The difficulty of this problem can be illustrated by considering the tremendous kinetic energy of a satellite. If this energy were transformed into heat, the heat gener-

ated would be many times that necessary to vaporize a satellite made of any known material—if all the heat flowed into the satellite. It is, however, well known that some meteorites do decelerate and reach the earth's surface. During the reentry process some of their outer skin is lost through evaporation and erosion.

A great deal of study of this problem, well known as the reentry problem, has recently been made in connection with the ICBM program. In particular, at the Avco Research Laboratory (working under Air Force sponsorship) techniques have been developed for the reproduction and study of flow about objects reentering the atmosphere at up to satellite speeds.

We have made measurements of the heat transfer, of the radiation that would be produced by the hot air, of the electrical properties of the air, and of many other physical phenomena that will accompany reentry.

As the satellite heats it also begins to decelerate rapidly so that at peak heating it is decelerating at about 4 g's. After peak heating, deceleration continues to build up even though the exterior skin of the satellite and its parachute are already cooling, and it eventually reaches a deceleration of nine times gravity. This deceleration is again within the tolerance limits of men properly supported in a nearly prone position. After peak deceleration, the satellite will gradually slow up to a very low speed and the parachute will return it gently to earth. The falling phase will take about one-half hour. The satellite will strike the earth with an impact comparable to that experienced by objects dropped in a cargo parachute.

HISTORY OF AVCO WORK ON MANNED SATELLITE DESIGN CONCEPTS

About 2 years ago we at Avco Research Laboratory recognized that within the next few years two major barriers to the accomplishment of manned space flight would be removed. These previous barriers were:

1. The lack of a large rocket-propelled launching vehicle capable of lifting a few thousand pounds into an earth satellite orbit.
2. A lack of precise understanding of the fundamental problem of reentry heating of satellite vehicles. This knowledge has been obtained as a logical extension of research following IRBM and ICBM reentry studies.

Furthermore, the development of the ICBM was recognized to represent a tremendous investment of this country's resources. Accordingly, we believed that the ICBM should be exploited to the fullest extent to obtain the maximum value from the millions of dollars invested in its development.

Following discussions with ARDC, a study was directed toward the launching of manned vehicles and culminated in a proposal which was submitted to ARDC headquarters on November 21, 1956, for a "Manned Ballistic Rocket System Study." This proposal was coordinated within the ARDC structure, given technical approval, and assigned a high priority in the spring of 1957. Although no contract was awarded for this work because of lack of funds, study was continued with Avco funds. The results of this study indicated that a manned satellite system based on ICBM launchers was feasible. To reflect this advance in thinking, a "Minimum Manned Satellite" proposal was submitted on November 20, 1957.

MAJOR OBJECTIVES OF THE MINIMUM MANNED SATELLITE (MMS)

The primary objectives of the MMS were as follows:

1. To establish in minimum time a manned orbital flight capability with controlled reentry to a selected landing location.
2. To determine the problems of maintaining a man in space with an approximation to his terrestrial capabilities.
3. To establish the capability of placing a manned vehicle into orbit from which he can either land safely on earth or move out to a permanent orbit by use of practicable space propulsion devices. This orbit we refer to as the "orbit of decision." Achievement of this objective would be the major breakthrough in establishing manned space flight as a reality.
4. To demonstrate the advantages of a drag vehicle for accomplishing a safe, controlled, manned reentry from a satellite orbit.

EVOLUTION OF DESIGN OF MMS

In the course of the above study many different types of rocket-launched manned vehicle systems have been explored. Initially it was thought that a gradual approach to orbital flight would be most effective. This is analogous to the X–15 approach that Dr. Dryden explained to you. In this concept a manned vehicle would be launched to gradually increased velocities and altitudes until finally true satellite flight is obtained. It became apparent, however, as the study progressed, that the reentry of a manned vehicle is most easily accomplished from orbital flight. For accomplishing this reentry, both winged and unwinged vehicles with variable lift and variable drag were considered. While some of these ideas showed merit in specific problem areas, we were led to the logical conclusion that a pure drag reentry vehicle was greatly superior in satisfying the overall system requirements.

HOW SOON CAN THE MINIMUM MANNED SATELLITE BE REALIZED?

More than a year ago it was recognized that the earliest date on which a manned satellite vehicle could be realized was to be governed not by the time for development of the satellite itself. Rather, the earliest date would be determined by that on which a safe and operationally reliable launching vehicle would be available. To achieve this reliability, a certain minimum number of successful firings of an ICBM are required.

Because of the overriding importance of the reliability factor in any American manned space flight, we turned quite naturally to the ICBM which had been tested most, the Convair Atlas. Accordingly, we discussed the matter with the Convair Astronautics Division of the General Dynamics Corp. As a result, an agreement was reached whereby a joint corporate proposal would be made to the appropriate authorities. We are firmly convinced that this Avco-Convair team can produce the earliest realization of manned space flight. This proposal is to be presented to ARPA on the 2d of May.

CONCLUSION

In conclusion, it appears that at the present time no great scientific discoveries are needed to achieve manned space flight. It thus becomes a matter for decision. Is America willing to pay for it?

It is not yet clear how or whether manned space flight will be important in a military sense. Historical perspective, however, may be useful to supplement the deficiencies in our imagination. Some of the revolutionary weapons of this century were the airplane, radar, and nuclear energy. In all of these cases the initial developments were undertaken with nonmilitary objectives in mind. The airplane was once just a challenge similar to that of the present-day potential of space flight. Radar was once just a powerful way of studying the ionosphere. As for nuclear energy, the original applications were not to bombs but to the generation of power.

It is my opinion that America cannot afford the gamble that this pattern will not be repeated in space flight.

Mr. O'Brien. Thank you very much, Dr. Kantrowitz.

I was interested in the reference to adventure. I think to a certain extent we might use the word "gamble." Gambling with ideas. Would it be your thought that there would either be a separate agency or an agency within the proposed agency that would deal specifically with the personality of scientists, plus the probability of success in the particular project we are interested in; in other words, not tie it down to an immediate military objective or an immediate appropriation that might or might not be approved by Congress? Is that the idea? You want a field in which the scientists with an idea, who is willing to risk his time and reputation, can operate?

Dr. Kantrowitz. That is right; whether his objectives have been purely scientific or militarily important. The point I was registering a sort of inarticulate objection to is the kind of committee system under which we operate which prevents the person who has ideas which are not yet popular from getting the kind of support that he could have when he can just operate on his own funds, as the Wright brothers did, for example. This is a very difficult thing to do nowadays.

Mr. O'Brien. In other words, he could go so far without investment of tremendous sums.

Dr. Kantrowitz. In many cases he could.

Mr. O'Brien. Then he would arrive at a point where huge sums are necessary. When you get to the tens of millions, then this agency could exercise this judicious function.

Dr. Kantrowitz. I think they should depend greatly on the reputation of the individuals who are willing to risk their reputation and their time in the execution of a project rather than depending heavily on the advice of people who will not be involved with the project personally, whether it is accepted or not.

This judicial function I think tends to maintain tradition at the expense of the adventurous approach.

Mr. O'Brien. The exercise of the judicial function around 1492 would not have resulted in the competition by Columbus.

Dr. Kantrowitz. I would think so. The climate of opinion I think was against it at the time.

Mr. O'BRIEN. I know that you and several others speak very confidently of this manned space travel and going to the moon. Actually, scientifically you are more certain that man in a vehicle will go to the moon, go into space, than the scientists just a few hundred years ago were that the world was round; is that right?

Dr. KANTROWITZ. I think so. You will find statements in the press, perhaps some before your committee, that people have the impression that manned orbit flight is a long way off. With this I disagree. It can be a long way off for this country. Whether it is a long way off for the Russians, I don't know. I think we can do it quickly if the authority is forthcoming.

Mr. O'BRIEN. I have one final question:

In this suggestion of yours that scientists be given an opportunity for Government help if they are willing to risk their reputation, would that not be a quick way of achieving this leapfrog idea that we all have in mind?

In other words, I think a great many of us are tired of playing tag with the Russians; we would like to jump ahead of them.

Dr. KANTROWITZ. That is right. We will take a chance, we will make mistakes this way, but it won't be as humiliating as being behind the Russians.

Mr. O'BRIEN. We still have some people in the country that figure we have three up now, the Russians have none, we are leading the ballgame 3 to 0, so it is time to buy another bag of peanuts and watch the game.

Are there any of my remaining Democratic colleagues that have any questions?

Mr. SISK. Mr. Chairman, I would simply like to ask the doctor in the extension of his remarks in the record to make a statement with reference to whether or not you feel that the proposed legislation which this committee has before it is a proper vehicle or provides the proper method for expediting and giving to you and to other scientists and engineering people the weapon to proceed to do this job as quickly as possible? I am not going to ask you to comment at the present time, Doctor; I realize it is quite late. But in the extension of your remarks which you will be given the privilege of doing, discuss the legislation. I am sure you have read the bill.

Dr. KANTROWIZ. I have read it, but I do not consider myself competent to say whether that bill will provide what I am asking for.

Mr. SISK. I would appreciate your criticism, but if you prefer not to, I will withdraw my request.

Dr. KANTROWITZ. Thank you, sir.

Mr. SISK. Thank you, Mr. Chairman.

Mr. O'BRIEN. Mr. McDonough.

Mr. McDONOUGH. Dr. Kantrowitz, I appreciate your statement. You have a very, very vivid practical view of the future on this spaceflight business. Coming from one who has experimented and speaks with some authority on the subject, it is very refreshing to know. In other words, we can do this if we get to work and get at it.

Dr. KANTROWITZ. That is it.

Mr. McDONOUGH. And speaking of the potential educational facilities that we have in this country and the present inventory of scientific manpower and brains, how in your opinion do we stack up against the rest of the world?

Dr. KANTROWITZ. I have for some time been very much worried about the tremendous Russian emphasis on scientific and engineering education. I feel, however, that our educational system is a reflection of the general climate of thinking in this country, that this has been improving fundamentally, that we have been humiliated once with the sputnik. We are moving in the direction of appreciating these things more at the grassroots level, and this will be reflected in time in the areas that are important.

I fear, however, that the many years' lead that the Russians have on us in this educational race will not be made up, that we will be faced in the future with many humiliations of the sort what we have had in the sputnik business.

Mr. McDONOUGH. Outside of the space technology, in what other scientific fields are they advancing faster than we are?

Dr. KANTROWITZ. I do not think that there are many areas where they are currently advancing faster than we are. The thing that alarms me is that they are educating larger numbers of people.

Mr. McDONOUGH. Under rigid discipline.

Dr. KANTROWITZ. Under rigid discipline, but so far as I can tell in the last few years, at least, the rigid discipline does not prevent freedom of scientific thought. There was a period when it did, the Lysenko kind of regime there, but so far as I can tell, that is not any longer the case. Their repression of civil liberties in other areas does not extend to an interference with the freedom of scientists to do purely scientific work.

Mr. McDONOUGH. It is my opinion that on the broad front, taking the broad scope of scientific and intellectual advancement of mankind, that we are way ahead of the Russian people and I think we have much evidence to prove it by our industrial know-how, our production, but I do believe that we have become a little too intoxicated with our own abilities and have not become conscious of the need to continue these things and that there is too little attention given to the requirements of basic studies in the lower grades of school to encourage young people not to be so engrossed with rock and roll but be a little more interested in good literature and good music, and things of that sort.

Dr. KANTROWITZ. I would say it in this fashion: For many years this country was unquestionably the leader in mass education; in the education of large numbers of our people we far excelled what was done any place else in the world. This, unfortunately, is no longer true. Our past efforts in this regard, however, have given us a tremendous backlog of know-how of people were educated 10 or 20 years ago. But at the present time our rate of production of new scientists and engineers is certainly lower than the Russians, so that we are living in the meantime on our backlog of educated people, which is comparable to that of the Russians or maybe a little larger.

Mr. McDONOUGH. The world was pretty much impressed by the shooting of Sputnik I and II into orbit, and because of that they appropriate to themselves all other scientific advances that they probably don't have and have not proved that they have.

Dr. KANTROWITZ. Of course, but there is real danger for the future in such great contests as the contest to make a controlled thermonuclear reactor, which in my opinion is at least as important as space.

These contests we don't dare to lose. They are too important. Space and the thermonuclear reactor are vital.

Mr. O'BRIEN. A great many people are concerned with the possibility that in attempting to catch up with the Russians in science education that we will go too far and strain out the humanities entirely. Don't you feel that it is possible with a little reorganization of our school system to retain the humanities and still produce more scientists?

The reason I say that is that I have observed some of you people who appear before this committee and I have yet to find a mad scientist before us. I have found that nearly every one was articulate in other fields, indicating a background which was not confined purely to science. I do not think in this country we want to turn out a lot of people who are scientists and nothing else but little monsters.

Dr. KANTROWITZ. I would like to submit this notion regarding science and the humanities. It is my opinion that in our times the great creative medium, the great art form of our times is science and technology. The humanists in the universities more frequently are concentrating on the past and not the present as compared with the scientists who are so closely a part of our society today. I think just as music captured the imagination of Vienna in the 19th century, in the same way science and technology are the important kind of creative activity which mean something to the people nowadays.

Mr. O'BRIEN. In one respect do you not think that the spectacular part of all this business we are discussing now is going to have an impact on our education, it is going to create the desire on the part of the youngster to get in that field?

He might be shooting off these rockets that Mr. Fulton is worried about, but he is interested. I think you are going to have the youngsters clamoring for the opportunity, and they might bend this educational system a little bit with help from their parents.

Dr. KANTROWITZ. I was a professor at Cornell University for 10 years, and it has been my experience that the influence of the students on the educational structure of the university was a most beneficial one. Their guidance, the way that they were able to choose professors and to affect the curriculum, showed that they were in many cases wiser than the faculty. It seems to me that this is a very hopeful thing.

Mr. O'BRIEN. I think that Mr. McDonough put his finger squarely on the point. I think most of the responsibility in our failure to keep up with the Russians lies in the arrogance of our generation. I can remember not too long ago, when we were ahead with the atomic bomb, hearing a person whom I respect say, "The Russians are such a backward people; give them the bomb and they will probably blow themselves up."

Then we kept drawing over ourselves a very fine blanket, "Oh, when these German secientists which they captured die, they won't have anything left."

We have seen that exploded in the testimony here. That is a terrible fallacy.

Dr. KANTROWITZ. Yes; but it was widespread just as right now a lot of people think that because we have satellites up there now, it is time for the seventh-inning stretch. I think the youngsters might change that.

Mr. FULTON. Do you not think it is a good thing that Russia is educating her young people, because I understand now because of objections of the students in the Russian's higher institutions of learning, as well as the middle ones, that the komsomol, the Communist youth organization, is not allowed in the schools any more, nor are the Communist political officers permitted in the classrooms or laboratories.

Dr. KANTROWITZ. That sounds like wonderful news.

Mr. FULTON. When you realize that they are educating a whole new generation of educated people, that are raised within a spirit of inquiry rather than rigid polemics, and also raised under a free enterprise system, that if you do well you are encouraged and paid better, maybe they are raising a generation that we can live with.

Dr. KANTROWITZ. That sounds wonderful, Mr. Fulton. I would think it a great thing if we could gain enough confidence in that so that we would not have to worry so desperately as we now do with our military posture. I think too until we gain confidence that we can live with the new generation of Russians that our military posture is absolutely essential.

Mr. FULTON. I am certainly for a good strong military posture now, but I am looking for the future. I just did not want to hear bad comments about a nation educating its young people in a spirit of free enterprise. I think that is rather good.

Dr. KANTROWITZ. It is good in the long view, perhaps, but in the short view it is dangerous.

Mr. FULTON. Have you heard the comment that they have made a survey—we can't tell how accurate—of the Russian college and postgraduate level of students, and have found that there are fewer Communists on the average in the Russian schools than there are on the average in France and Italy combined, in the same age levels?

Mr. O'BRIEN. Would you not say that there are more people in the Russian schools that thoroughly believe it is necessary to destroy us in order to accomplish their objective, whether they are called Communists or not?

Mr. FULTON. Do not misunderstand me. I believe we in the United States need a firm military posture and I voted that way right straight through and voted for defense last year as a Republican, which made me look as if I was not for economy. But we must keep our minds open so that once the dictatorship becomes either weak or overthrown, we do have the chance without destroying each other to develop a world that we all can live in.

That alternative is entirely possible, and should we not work for that?

Dr. KANTROWITZ. We can all remember the history of the Reformation, that it was a bitter time for many years, and suddenly one wonderful word was discovered, "tolerance."

Perhaps there will be some analog to that word that will be discovered nowadays.

Mr. FULTON. You see, rather than have all the witnesses here with their hands up in horror on what might come in the future, I am an optimist. I think the world will work out well. I predicted to General Gavin that the next war will be without casualties, that there will be counters up in the air, because whoever can get higher within a

certain range can control the earth. That means we will be moving the military power out into space; will it not?

Dr. KANTROWITZ. It is conceivable.

Mr. FULTON. If that is so, it will be, as I saw down in Guantanamo Bay with two Terrier rockets fighting a World War II plane. They knocked it down with much evasive action. There was not a soul in either one of them. It was very interesting.

So by a system of counters in outer space we would then have the next war, and when they had lost a sufficient number of counters they would know it was over, that was the end of the war. Could that not be?

Dr. KANTROWITZ. It is much farther than my own thinking has gone.

Mr. FULTON. That is why we are hearing you and you are hearing us. Thank you.

Mr. O'BRIEN. Mr. Feldman.

Mr. FELDMAN. Last Friday, Admiral Rickover stated he believed we should wait for atomic-powered rocket engines before attempting to launch a man in a satellite vehicle. Do you believe it is necessary to wait until then?

Dr. KANTROWITZ. I would say most emphatically no. I think that the advent of a powerful nuclear rocket, capable of lifting a manned satellite off the earth, is a very long way away. I think we must reckon with the fact that to carry a reactor aloft in a rocket requires us to have not only a nuclear rocket but one of tremendous reliability because an accident which could spread radioactive material over large parts of the earth would be very dangerous.

Mr. FELDMAN. We have seen pictures of large rockets blowing up on a test stand at the time of launching. In your planned manned satellite capsules would you have any emergency escape procedure?

Dr. KANTROWITZ. We have provided escape procedures which will be effective in all parts of the flight where there are likely to be any disastrous failures.

Mr. FELDMAN. What duration of flight would you propose for the first manned satellite flights?

Dr. KANTROWITZ. I would propose that we do something of the order of a few days. Shorter flights than that require a very great guidance precision and longer flights would require too much in the way of survival equipment.

Mr. FELDMAN. Do you believe that your manned capsule concept could be adopted equally well to the Titan?

Dr. KANTROWITZ. That is correct, it could equally be adapted to the Titan ICBM. The reason we have chosen the Atlas is that we believe it will be reliable before the Titan will be reliable.

Mr. FELDMAN. This morning Dr. Dryden told the committee that "Ion propulsion as a system is not ready for development, also ion propulsion must await the availability of ion rocket vehicles capable of placing hundreds of tons of payload into orbit." Do you agree?

Dr. KANTROWITZ. I most emphatically disagree with that statement.

Mr. FULTON. May I congratulate you.

Dr. KANTROWITZ. Thank you, sir. I would most emphatically disagree with that statement. I would say that electrical propulsion systems in the first place are not a dream. We have, for example, in

our laboratory a contract with the Air Force Office of Scientific Research for the study of such systems and we have achieved an electrical propulsion system which produces a jet which has some 100 times the velocity of the jet from a chemical rocket.

This makes possible the application of electrical propulsion systems to all flights outside the atmosphere. And I believe that the scheme for the future development of space flight will be the launching of orbital vehicles at low altitudes, 100 to 150 miles, by chemical launchers such as the ICBM rockets, that from there on electrical propulsion systems powered either by solar energy or by nuclear energy in various forms will be the practical propulsion system. I therefore have very little interest in projects which call for going beyond the satellite orbit with the use of chemical rockets at this time. I feel that these things will not be in the mainline of the development of space flight. I feel also that the development of electrical propulsion systems is something which should be undertaken now so that we can have more assurance that these devices can be built into our planning of space flight. We are undertaking such developments in our laboratory now.

Mr. FELDMAN. I think Dr. Dryden also told us that ion propulsion is not practical except for distance of a million miles from the earth.

Dr. KANTROWITZ. This is a mistake he made. I talked to him afterwards. He agreed that it was not right. What he was doing is imagining you could go far enough away from the earth so that you could lift yourself straight up. The practical way to do it is to go into a satellite orbit around the earth and propel yourself out in a spiral which can be done above the atmosphere at altitudes of more than 100 miles.

Mr. FULTON. When you have 10 pounds of thrust on an ion-propelled vehicle as against a weight of about a pound and a half at the distance of maybe 20,000 miles from the earth, that is quite a good leverage.

Dr. KANTROWITZ. At this point I agree with Dr. Dryden and disagree with you, sir.

Mr. FULTON. Why?

Dr. KANTROWITZ. Because the important thing in moving an object away from the earth is to overcome essentially its inertia. Its inertia is not affected by its distance from the earth.

Mr. FULTON. Yes, but when you have ion propulsion it builds up as gravity does at an accelerating rate so that it keeps adding on and adding on as time goes on, and while it is slow, you might have to make some circles in order to get the distance.

Dr. KANTROWITZ. That is right, and in my opinion this is the most promising method of going beyond the satellite orbit.

Mr. FULTON. That is what I think.

Dr. KANTROWITZ. This is something I feel quite enthusiastic about.

Mr. FULTON. Thank you. That is all I have.

Mr. FELDMAN. Can you compare the technical problems of reentry of a manned satellite orbit versus the Army's 150-mile manned rocket?

Dr. KANTROWITZ. I agreed quite completely with Dr. Dryden on this issue, that the problems that von Braun would face in sending a man up in a ballistic missile trajectory and bringing him back after reaching a peak altitude of 150 miles, are quite different from those one would face in reentry from a satellite orbit.

The only thing that you would learn is what happens to a man in 6 minutes of weightlessness. I feel therefore that this is another

project which is off the main track because I feel that weightlessness is not a great problem. Therefore, I am quite in agreement with what Dr. Dryden said.

Mr. FELDMAN. Your technical reputation in high-speed aerodynamics and reentry problems is well recognized. Do you feel that a manned satellite is a really feasible and important goal? Would you be prepared to undertake such a program, and what time scale do you see?

Dr. KANTROWITZ. I feel that the reentry of the manned satellite into the atmosphere, granting that the ICBM achieves its specified performance, is well within our current knowledge. We can do it, using well-known materials and well-known principles of aerodynamics. In regard to the importance of this, it is my feeling that manned space flight is part of the mainline of the development. There is, of course, a great amount of information to be obtained from instrumented space flight but I think that these things will only be important until one has manned space flights and then they will become of minor importance compared to what man will learn.

Mr. FELDMAN. What time scale do you see?

Dr. KANTROWITZ. I see a time scale of 2 to 3 years, granted a high priority but not a terribly expensive project, because it utilizes Atlas boosters which are already developed. It requires that the production of Atlases be slightly increased in order to provide test vehicles and it requires the development of the man capsule, itself. I think all of this will come to considerably less than $100 million.

Mr. FELDMAN. No further questions.

Mr. FULTON. Could I just finish a thought?

Mr. O'BRIEN. I was going to suggest that maybe the gentleman from Pennsylvania would like to ask this obviously well-qualified witness that question of his about pull versus drag, although to me the terms are synonymous.

Mr. FULTON. I have tried everybody and I don't know whether they can be a Navy lieutenant or not under the present examination. I would like to hear you as a fellow scientist.

Mr. O'BRIEN. The only comparison, and this is not scientific, all I can think of is an ossified fellow at a bar; he was not moving in any direction.

Mr. FULTON. We might ask you to put in the record what you think of that.

Dr. KANTROWITZ. Would you please state the question?

Mr. FULTON. The question is on a vehicle in atmosphere or space when the thrust equals the drag and the lift equals gravity, what is it doing?

Dr. KANTROWITZ. I would say that it was in straight level flight.

Mr. FULTON. In continuous, unaccelerated, constant level flight. I guessed at that but it was not right. I answered it that way on the examination.

Dr. KANTROWITZ. Did you pass or fail?

Mr. FULTON. Could it possibly be a plane when it comes to the stall point in its climb?

Dr. KANTROWITZ. No, the stall point of the plane is when it is decelerating.

Mr. FULTON. Right at the stall what is it?

Dr. Kantrowitz. You are decelerating, you are losing speed at that point, which is the fundamental reason you lose lift thereafter.

Mr. Fulton. One point where I would like to make a comment, because you are in this field: Going back to our ion propulsion, both you and Dr. Dryden are acting as if there was an object stationary in space, that the vehicle starts with ion propulsion from a dead start with plenty of inertia.

I would agree that if there were a dead inertia then it might be hard to start because there is nothing to start it against. But on the other hand, where there is a vehicle traveling at a speed that we have used to get out of the atmosphere around the earth, then the question is that when ion propulsion takes over, it then increases acceleration of the speed that you already have. Again from ion propulsion, to me, is that it keeps building up like going up a pyramid, a continuous acceleration, so that in time if you had a trip of a year with ion propulsion you would be going at a tremendous rate of speed which then, to use your own words, could be coasted almost anywhere.

You see, you could build it up and then coast it.

Dr. Kantrowitz. That is quite correct.

Mr. Fulton. Once you build it up with a ion speed, suppose you put it in the atmosphere with a tremendous orbit and you let it go for maybe 10 years, we might have fantastic speeds we don't know anything about. Isn't that right?

Dr. Kantrowitz. I would think in 10 years with any appreciable amount of acceleration you would approach velocities close to the velocity of light which would provide a sharp limit.

Mr. Fulton. One thing is sure: Neither you nor Dr. Dryden nor I know what the value of inertia is of objects in space that are away from gravity or electronic controls.

Dr. Kantrowitz. I disagree with that. If you remember the history of our understanding of mechanics, this was first achieved by studying objects in space and particularly by the orbit of the moon. Newton's first achievement of the real understanding of what was going on was by understanding the behavior of a body in space where it is simplest. This has been checked many times.

Mr. Fulton. You and Dr. Dryden are trying to take the position that a 10-pound thrust continuously accelerated on a magnitude of 1½-pound weight in space is not an effective propellent.

Dr. Kantrowitz. The next question is, what is the basis? In our own proposals for accelerating a manned satellite to a higher orbit, we have used thrusts as small as one-thousandth of a pound with effect. It takes time.

Mr. Fulton. Then you are very encouraging to me.

Dr. Kantrowitz. But we accelerate very slowly when we do that.

Mr. Fulton. That is right, but I have accepted that. I have spoken more of the fact that when (and you and I agree) we pass beyond the atmosphere—we are going at a pretty good speed, so that acceleration with ionic propulsion is added to the particular speed we had when we exited from the earth's atmosphere.

Dr. Kantrowitz. It is more efficient as you go to higher speeds, this is correct, but it still accelerates you very slowly.

Mr. Fulton. Thank you very much.

Mr. O'BRIEN. Doctor, I want to thank you for the committee and myself, first for your patience in waiting and, secondly, for your very interesting and informative testimony. We are grateful to you.

Dr. KANTROWITZ. Thank you.

Mr. O'BRIEN. If you care to you can expand your comments when you have an opportunity to edit your testimony.

I might announce for the benefit of the remaining members that we are meeting at 10 o'clock tomorrow morning in room 356, which I understand is just around the corner.

(Whereupon, at 6:05 p. m. the committee was recessed, to reconvene at 10 a. m. Wednesday, April 23, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

WEDNESDAY, APRIL 23, 1958

House of Representatives,
Select Committee on Astronautics and Space Exploration,
Washington, D. C.

The committee met, at 10 a. m., pursuant to recess, in room 356, Old House Office Building, Hon. John W. McCormack, Chairman, presiding.

Present: Representatives McCormack, O'Brien, Metcalf, Natcher, McDonough, Fulton, Keating, and Ford.

Also present: George J. Feldman, director and chief counsel.

The Chairman. The committee will be in order.

The first witness is Brig. Gen. H. A. Boushey, Deputy Director of Research and Development, of the United States Air Force.

We are glad to have you before us, General Boushey. We will be very glad to hear from you.

STATEMENT OF BRIG. GEN. H. A. BOUSHEY, DEPUTY DIRECTOR OF RESEARCH AND DEVELOPMENT, UNITED STATES AIR FORCE, ACCOMPANIED BY LT. COL. FRANK DILLON

General Boushey. It certainly is a pleasure to be here this morning, Mr. Chairman.

I have a few remarks which I have written to refresh my memory. With your permission I would like to read them now, if I may. They They should not be too long. It should not take more than 12 or 13 minutes.

Shall I proceed?

The Chairman. Yes, you may proceed.

General Boushey. Mr. Chairman and members of the committee, and counsel, man's future is inevitably linked with the problems which this committee is considering. Thus, I feel honored that you have requested me to appear before you today to present my views, views which I recognize may be controversial, but nevertheless, ones which I believe sincerely, and which I shall attempt to present clearly and concisely.

We in the military services sincerely pray that weapons of space may never be used, but, rather, that peaceful benefits of space may be freely enjoyed by all men.

However, I have been called before your committee as a military witness, and thus I shall try to limit my remarks to those which are pertinent to the military potential of space.

But at the outset, I would like to make one observation. Past experience has shown that some of our most respected thinkers have

failed to appreciate new concepts. Typical expressions of our military and scientific past come to mind—"Steam will never replace the sail;" "The airplane can never sink a battleship;" "Power can never be obtained from the atom;" "A jet engine will always be too inefficient to be useful," and, fairly recently, "The hydrogen bomb won't work."

So, I feel we should analyze proposals with intelligence and imagination, for again and again, the "absurd impossible" of today becomes the reality of tomorrow.

From a military consideration, the debate of the space age can be narrowed to two questions. These are:

1. Can space power provide significant military advantage? and
2. If this be true, what specific military applications of space power will give us the greatest advantage?

Now, without claiming to be the only persons who have considered these critical questions, we in the United States Air Force, on the basis of actual military experience, feel we can answer the first question in terms of plainest common sense.

For years our job has been to achieve, and at times to exercise, a dominant capability to deliver firepower against an enemy by military operations above the surface of the earth. In doing this job we have been, and still are, guided by one major premise, that a decisive margin of advantage goes to the nation whose delivery vehicles can attain the greatest speed, the greatest range, and the greatest altitude.

The battle tested validity of that premise has impelled the Air Force to continue its efforts to fly higher, farther, and faster.

The technical endeavors that have been accelerated and intensified by this program have produced truly spectacular results.

For example, the improvements in rocketry, guidance, and hypersonic aerodynamics which are incorporated in our intercontinental and intermediate range ballistic missiles are truly major technical advances. But these, and other achievements are well known to this committee and need no elaboration.

It is a fact that the first military space weapons will be the Air Force intercontinental and intermediate range ballistic missiles Atlas, Titan, and Thor.

To these should be added the Army's Jupiter and the Navy's promising Polaris.

While these missiles only remain in space a relatively short period of time, they do leave the sensible portion of the atmosphere and during this time they respond only to astronautic laws, the basic laws which control the motion of the bodies of our solar system.

Such weapons are space weapons, and they produce tremendous improvements in the range, speed, and reaction time of our Nation's deterrent force.

It thus becomes obvious that the answer to our first question: "Can space power guarantee significant military advantage?" is a decisive yes.

This brings us to the second question: "What other specific military applications of space power will give us the greatest advantage?"

And by "other specific military applications of space power," I refer to space vehicles which can operate above the earth's sensible

atmosphere for longer periods of time and which are not earth based. These space vehicles include primarily manned and unmanned satellites, piloted, maneuverable space craft, and eventually even an inhabited lunar base.

Nobody at this time can present a fully detailed chart of future space operations. There is too much still to be learned, and there are too many theories still to be tested to submit a bill of particulars.

But I do have several firm convictions regarding our development of space power.

First of all, I do not believe that machines alone, controlled from earth, can establish a capability to dominate space. I do believe that piloted vehicles are also essential to insure that our space systems can respond flexibly and promptly to unforeseen changes.

I also believe that on the spot exercise of human intelligence, judgment, and discrimination will be needed for effective control of space.

Undoubtedly various types of earth-circling satellites will prove useful, not only for military needs, but for peaceful purposes as well.

I am sure the committee already appreciates many of the valuable functions which such satellites can perform.

One of the most attractive features of an earth circling satellite is the tremendous improvement in telescopic and photographic resolution which is possible because of the total absence of atmosphere.

What may not be widely recognized is the degree of detail which could be distinguished from, say, a 500 mile orbit. With only a 40-inch diameter telescope, it is estimated that objects on the earth of a size less than 2 feet could be detected.

If a 200-inch diameter telescope, the size of the present Palomar reflecting mirror, were located in space at the "stationary orbit" distance of roughly 22,000 miles, objects on the earth approximately 17 feet in diameter could be viewed.

I believe man will be an essential element for such an observation platform. Even the problem of deciding where to look is a formidable one, and if left to a mechanical device the chances of profitable search and detailed scrutiny would be far less than if under the direct supervision of an intelligent operator who could immediately exercise the faculties of suspicion, comparison, and reason.

Such an orbiting reconnaissance platform might very well improve earth-based ICBM warning times by a factor of two. Enemy missiles as they rose above the atmosphere during launch could be detected clearly and warning transmitted to the free world in half the time of our best earth-based early warning systems.

Another function which I believe only man can perform effectively is that of interception and midspace rendezvous. At first, such missions probably would be for the purpose of refueling, thus permitting a manned, maneuvering space vehicle to receive fuel from an uninhabited tanker satellite which might have been circling in orbit for months or years.

If such refueling operations were not utilized, the size and costs of vehicles for true space exploration would be vastly greater, and our time-table for manned flight to the moon or Mars and Venus would be extended greatly.

Eventually, the capability to control space would be augmented by the ability of manned military space craft to make interception or rendezvous in space.

Various other types of unmanned earth circling satellites will undoubtedly prove useful, but a frequency overlooked requirement, that of maintenance and resupply, will require the use of manned space craft.

Malfunctions of automatic equipment do occur. Periodic replenishment of parts and fuel will be desirable and preferable to the alternative, uneconomical use of "one time disposable vehicles."

It is inconceivable to me that any method other than by manned maneuverable space craft could effectively perform this vital maintenance function.

But man's usefulness in space becomes most apparent when considered in relation to our only natural satellite, the moon.

I realize that many experts have had many varied opinions about the moon. I happen to be one that feels it will be extremely useful. These are my own opinions and if I may I would like to express them freely.

My personal conviction is that ultimately the establishment of an inhabited lunar base will provide numerous advantages, both civilian and military.

Materials synthesized from matter obtained from the moon itself could be used for construction, and the support of human life. Oxygen could be extracted from the ores of the moon, and even water could most probably be obtained from its minerals.

I have been told that magnesium silicate contains approximately 15 percent water in crystalline form. If that were not available, many of the hydrides could be used, the hydrogen extracted and burned with the oxygen to form water.

We don't know what the moon is composed of, but until somebody has a better guess, we have to assume it is composed of much the same stuff as the earth is.

As the Russians recognize and so stated in their space movie "Blazing Roads to the Stars," rocket fuels could be synthesized from lunar material. The cost is great, in both dollars and energy, to place any material at a location having only one-sixth earth's gravity.

Since the moon abounds in material, it is destined to become the launching site for further explorations of our solar system, and perhaps even the best supply base for lower orbit, earth circling satellites.

Lunar conditions would offer unparalleled advantages for astronomical observation. For example, today from the earth, using present telescopic and photagraphic equipment, it is possible to detect an object approximately one mile in diameter, or not a great deal larger than the Pentagon, including its parking lots, for the Pentagon building alone is over one-third mile in diameter.

If you have ever walked from one end of the parking lot to the Pentagon, you can appreciate that the complex is more than a mile in diameter.

Even assuming no improvement, a lunar station having no better optical resolution would be very useful. Worldwide weather surveillance needs resolutions of many miles, not feet, and would be of undisputed military advantage as well as peacefully benefiting mankind throughout the world.

But the optical resolution would improve considerably once beyond the earth's atmosphere.

Mr. Chairman, at this point, I have little demonstration. I will pass out two cards and a semitransparent screen. The screen scatters the light. If you will hold the transparent or semitransparent screen close to the black dot, you will see that it can be seen readily. If you move the scattering screen toward your eye, due to the scattering effect which is similar to that of the atmosphere, you notice the resolution disappears immediately.

This I have been told by reputable astronomers is a valid comparison of conditions as they would exist on the moon looking toward the earth. The transparent film represents the atmosphere immediately next to the earth's surface rather than vice versa, where you cannot obtain good resolutions.

I think the analogy holds up to the extent of making the point clear.

Looking through our atmosphere with scintillations, scattering and thermal disturbances limits of visual acuity through a telescope.

On the moon the only limitation is that theoretically obtainable through the best optical instruments which man can devise.

As a rough figure, I have been told a 5-fold factor of improvement with existing telescopic lens systems, photochemical processes and so forth, would automatically take place once beyond the atmosphere of the earth.

There would be a 5-fold improvement in "seeing," and thus the diameter of an object which could be detected on the earth's surface from a lunar observatory would then be approximately one-fifth of a mile, or close to 1,000 feet.

During the next 15 to 20 years, with the inevitable improvements in optics, photochemistry, and especially electronic amplification of light, it would seem quite conservative to expect great improvement over present-day astronomical detection capabilities.

Such improvement would then permit detection from the moon of objects on the earth of the order of less than 100 feet, or sufficient to distiguish individual aircraft or missiles.

Now, I am not extrapolating far beyond what is available today. I am using figures which astronomical experts such as Dr. Evans of the Sacramento Peak Observatory, Father Heyden of the Georgetown Observatory and Dr. Lee Devol of the Aeronautical Research Laboratory and others have given me.

A proposal has already been made to build a 400-inch telescope, one twice as big as the one at Palomar.

So less than 100 foot object detection on the surface of the earth from the moon, so I have been told by people whose opinions I respect, is quite possible.

And, last, as regards the moon, I personally believe it could, at some future date, be used as a secure base to deter aggression. Lunar launching sites, perhaps located on the far side of the moon, which could never be viewed directly from the earth, could launch missiles earthward. They could be guided accurately during flight and to impact, and thus might serve peaceful ends by deterring any would-be aggressor.

But as regards the entire subject of space control, one thing is certain, the inevitable advancement of technology.

As General Putt stated last week, we in the Air Force do not expect to marry present-day concepts and weapons to future space vehicles. We do not know what precise form these future weapons may take, but advances, in other branches of science, will surely keep pace with space technology and provide in the future defensive weapons of undreamed effectiveness.

Above all else, we must be bold and imaginative about the future of astronautics. We cannot be inhibited by the lack of imagination or our inability to foresee the exact application of each element of our national space program. We must support a broad program of basic and applied research.

We cannot be overly fearful of failures, and thus attempt only the sure things which result only in a short-term gain.

The cost of testing radical ideas and techniques to the point of determining their feasibility is small indeed when compared to the price of step-by-step small-gain advancements to existing equipment.

Simultaneously, we must not let our deterrent power deteriorate by concentrating too great a proportion of our research and development efforts in astronautics.

This may be a strange thing to hear coming from me, but I feel we must keep up our guard and not let it down at this time by concentrating too much on astronautics.

Because we are a peaceful nation and will never strike except in defense of freedom, we must keep our present deterrent power strong and improve it simultaneously with our advance into the space age. The cost will be high, but it is a price which we must accept if our way of life is to prevail.

The Russians do not appear to doubt the desirability of obtaining Soviet, manned space capability, nor do they discredit the worth of manned exploration of the moon.

My own views are that we can win the race for space if we do so desire. And I feel we must win it, so that all humanity can profit from these benefits which God has surely placed within the reach of man.

The CHAIRMAN. General, I noticed on page 11 of your prepared statement, you say:

> We surely will keep pace with space technology and provide in the future defensive weapons.

That also might be offensive weapons, too?

General BOUSHEY. It could be, sir.

The CHAIRMAN. Mr. Metcalf.

Mr. METCALF. Mr. Chairman, I think the General has given us a very hopeful and optimistic statement.

You have read the testimony before this committee where some say there is no use getting on the moon. Others make such statements as yours, that it is very important, both to our defenses and for various civilian uses that can be made of it, but our immediate concern is how to achieve those objectives.

Now, with your experience in the Air Force, working in the research programs, what would you do if you were recommending the creation of a new department to achieve this base on the moon that you want?

General BOUSHEY. Mr. Metcalf, of course, I am aware of what other people in this field have testified and even said in print and privately. I could not help being aware of these things.

I am also aware of the proposal before the Congress to create a National Aeronautics and Space Agency.

In my opinion, having worked for many years with NACA, which would be the predecessor of that organization, I feel that we understand each others problems, we work quite harmoniously and the combined effort of the military and the scientific, to me, is something which historically has proved quite successful.

I am thinking of things in the past like the Lewis and Clark expedition where the military helped. It was opening the Northwest and it was at that time scientific.

I am thinking of Captain Cooke's voyages to the South Seas, done by a combination military, then naval—scientific effort.

This is how I feel this Nation could best go to the moon, or achieve the space efforts that I feel are required.

Mr. METCALF. I appreciate that the NACA has made an enviable record, both in research and development, and in public relations with the people with whom it has worked. But do you think that blowing up or expanding the NACA is the best way to do this job, or is it only one way to do the job?

General BOUSHEY. I would not pretend to be the expert and say there is only one way to do it, sir. In my opinion, greater expansion or blowing up of the NACA into the NASA would not be necessary.

The military services have spent many millions of dollars to obtain much of the needed equipment. I think this can be used harmoniously and effectively as a joint team effort.

Whether it is the best way, or the only way, sir, I could not say.

Mr. METCALF. We want to do it the best way, if we can. You have read the proposed legislation?

General BOUSHEY. I have, sir.

Mr. METCALF. Are you satisfied that the interest of the Air Force, the interest of the Defense Department and of the military in general are protected in that proposed legislation?

General BOUSHEY. Speaking frankly, for myself, I would like to see in the law a provision that uniformed representatives of the three services would actually be on the 17-man body rather than leave some doubt, as I believe the present bill does.

This is my personal view, though.

Mr. METCALF. Thank you.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. General, is the Air Force experiencing difficulty in securing trained people for your research and development program?

General BOUSHEY. If I understand the question, you are talking about contractor employees, or governmental employees, or both?

Mr. NATCHER. Both.

General BOUSHEY. I would say there is no difficulty, sir, in obtaining effective scientists and engineers through our contract efforts, but obtaining adequate experienced enough engineers or scientists through the civil service hiring procedures, I do feel there is a great difficulty.

Mr. NATCHER. Do you feel that here in this country the number of trained people is greater than in the Soviet Union today?

General BOUSHEY. I do not have knowledge about that, sir. From my general understanding, there is even an argument of the definition

of what is trained as compared to the Soviet techniques and our techniques.

I would guess at the lower level the number of technicians in Russia exceeds ours.

Mr. NATCHER. It has been stated from time to time that the United States has lagged behind from the standpoint of science and technology. But, General, is not a great deal of this based on the fact that Russia just during the past few years has suddenly blossomed forth as far as science and technology is concerned? Their achievements are of the past few years, beginning with the close of the World War II. Do you agree with that?

General BOUSHEY. Yes, sir; with a few minor exceptions they had a known interest in rocketry that went far back beyond World War I.

If you say a few years, the great impetus that the Russians received from the capture of the German scientists at Peenemunde in 1945, some 13 years ago, I believe is the basis of their present success.

Mr. NATCHER. General, you would not say it was entirely based on the seizure and capture of the German scientists, would you?

Do you not have to consider the fact that since World War II the Soviet Union has speeded up its school program, from the standpoint of development of trained personnel in the field of science and technology. In fact, testifying before our committee, Dr. von Braun stated very emphatically that in his opinion Russia did not secure from the captured German scientists everything that people in this country believe they secured.

General BOUSHEY. I agree with you wholeheartedly. What I meant in the immediate post World War II years is that what the Russians saw and learned from the Germans gave them the impetus and I think after about 1953 or perhaps earlier, they were able to carry on by themselves without the support of the German scientists.

Their educational program had come to that point in its abilities.

Mr. NATCHER. General, I believe you stated in answer to a question by Mr. Metcalf, my colleague, that you have examined the proposed bill before the committee?

General BOUSHEY. Yes, sir.

Mr. NATCHER. Do you agree, General, that this should be a civilian controlled agency?

General BOUSHEY. I do, sir, with the statement that I have already made, I believe the uniformed services should be represented on the 17-man board.

Mr. NATCHER. In other words, one member from each branch of the armed services?

General BOUSHEY. Yes, sir. One uniformed member.

The CHAIRMAN. Why do you want one from each of the branches, General? Why not from the Defense Department?

General BOUSHEY. Well, sir, I wonder if the services will receive adequate representation. The Department of Defense is a fairly large organization, as you know, and the facilities are spread across not only our continent, but some of our Pacific possessions as well and other parts of the world.

I feel it would take three people to justly represent all this knowledge, effort, and the facilities that are available on this board.

The CHAIRMAN. What about a liaison committee? Suppose this committee, in its judgment, should incorporate provisions providing

for a liaison committee between the new agency and the Defense Department?

General BOUSHEY. It might be very helpful, sir.

The CHAIRMAN. I mean that would be in addition to representation on the 17-man board, if that should stay in the bill.

Of course, the provision in the bill provides at least one. It does not confine it to one.

General BOUSHEY. Yes, sir; that is my understanding.

The CHAIRMAN. I was just exploring. If the committee in its judgment were to provide for a specific number of military representatives on the board, the 17-man advisory board, and it should be more than one, what is your opinion as to whether the number should be specified, with the Secretary of Defense having discretion to make the appointment?

General BOUSHEY. That might be a very adequate solution, sir.

The CHAIRMAN. In other words, if we cannot rely on his judgment, as to fair representation of the component parts of the Defense Department, then it is rather unfortunate.

General BOUSHEY. I agree, sir.

The CHAIRMAN. In other words, either 3, 1 from the Army, Navy, and Air Force, or 3 to be appointed by the Secretary of Defense.

General BOUSHEY. Yes, sir.

The CHAIRMAN. I think there is a lot of merit to liaison in these days, but there is no question we have to rely tremendously on the military. We just have to be practical.

I believe in civilian control, but I am not ignoring the importance of the military in the world of today and in the foreseeable future.

It means that the military, while not in a primary position, should not be put in a subordinate or secondary position.

As a matter of fact, the AEC really started out with a military emphasis.

General BOUSHEY. Yes, sir.

The CHAIRMAN. It was in 1954 that the transition took place, so far as civilian control is concerned. In 1954 they changed the AEC over to its present setup.

Under that, the military considerations were profoundly appreciated, as they should be.

General BOUSHEY. Yes, sir.

The CHAIRMAN. I think we can work it out. There will be no difficulty between what you have said. There is nothing inconsistent that I can see between what you have said and the views of most members of the committee.

Pardon me, Mr. Natcher.

Mr. NATCHER. General, do you agree that in taking that trip to the moon the spaceship would have to be as large as the Washington monument?

General BOUSHEY. No, sir; I don't.

Mr. NATCHER. What size spaceship could we use to take this trip to the moon, General?

General BOUSHEY. That would be a very hard question to answer, sir. As I mentioned, in my prepared statement, I think we can cut down the total size by putting fueling tankers in orbit and then a relatively small vehicle could get in the orbit velocity, refuel, go to

the moon, put an orbiting portion of itself with fuel in orbit around the moon, go to the moon, land.

Maybe the first man would stay there only long enough to erect some automatic reporting equipment, come back to the moon orbit, get the fuel he left there, come back to the orbit around the earth where there is more fuel and pick up fuel necessary for reentry.

The final vehicle that would land on the earth might be 12,000 to 15,000 pounds. The total size, I have been told, would be close to perhaps 900,000 pounds total if you consider all the boosters and stages to put these various things in orbit that you could use.

But, by orbiting, this is the ultimate in staging and you can cut down the total size and cost drastically.

Mr. NATCHER. General, do you have in the Air Force a timetable you are following now from the standpoint of outer-space exploration?

General BOUSHEY. Not to any degree in the future. We think the first steps, of course, should be to get unmanned satellites up and useful, then continue on taking the first steps, putting man in orbit.

Again, my personal view is the stationary orbit and the moon are two very important goals. Beyond that I think we should wait until we learn a little more before we fill in too many details.

Mr. NATCHER. Do you believe in 1958 to 1960 we might shoot a rocket close to the moon, then impact on the surface of the moon?

General BOUSHEY. Yes, sir.

Mr. NATCHER. General, do you further believe that from 1964 to 1966 it will be possible to land a vehicle on the moon with proper instruments and also to send manned rockets followed by scouting parties?

General BOUSHEY. Yes, sir. Unmanned, I think we might do it earlier than 1964 or 1966.

And with a man landing on the moon, returning to the earth, my own particular figure is around 1966.

Mr. NATCHER. Do you feel, General that in the year 1970, or sooner, we might be able to establish a permanent moon base and have a supply system set up and maintained at this particular base under our present Air Force research and development program?

General BOUSHEY. No, sir; I do not think so, because I will state generally I do not think the present program is of the scope you outlined. It may grow to that in the future.

Mr. NATCHER. General, you agree that this is one of the most important problems confronting the American people today?

General BOUSHEY. I certainly do, sir.

Mr. NATCHER. Are we warning our people sufficiently and advising them of the importance of this particular program? Are you doing it in the Air Force, and do you feel that the other branches of our military service are accomplishing this purpose?

General BOUSHEY. I will try to answer that as best I can, sir. I do not know if the services are doing their utmost, or what I would consider adequate to warn the people.

I do not think any better warning could be given any nation than Sputnik I and II. I am afraid some of the effect of that may have worn off.

I feel the people in the military services do try at every opportunity to bring to the attention of the American public the seriousness of the situation.

Mr. NATCHER. General, I certainly agree with you that some of it has worn off and we are now going back to our old complacency stage since we succeeded in placing our satellites in orbit.

But you agree that now it is imperative that we not lose any time in the development of our program?

General BOUSHEY. Indeed I do.

Mr. NATCHER. Thank you.

The CHAIRMAN. Are you acquainted with the Riehlman Subcommittee of 1954?

General BOUSHEY. I am acquainted with it, but I am not acquainted with the details.

The CHAIRMAN. Have you read the report?

General BOUSHEY. Parts of it.

The CHAIRMAN. Has the Air Force offered inducement and encouragement for officers to continue in specialized fields, particularly in the field of science and research and technology?

General BOUSHEY. Yes, sir; it does, in the way of advanced technological training and continuing assignments, we hope, in a field of great interest.

I think to the man that is interested in science, the ability to work and do something useful is even more important than the pay received, sir.

The CHAIRMAN. You cannot ignore that, either.

General BOUSHEY. No, sir.

The CHAIRMAN. But there has been a change in the last 3 years in connection with recognition of the importance of research and development?

General BOUSHEY. Yes, sir; I think so.

The CHAIRMAN. And particularly having trained officers, young men, starting out and making a career of it?

General BOUSHEY. Yes, sir; I think it was prior to 3 years ago we even changed the career name and number so that people specializing in research and development could specialize in that for a career.

The CHAIRMAN. And the opportunity of advancement in rank?

General BOUSHEY. Yes, sir.

The CHAIRMAN. I would have that ambition, myself, if I were in either one of the branches of the service. That is a human trait.

Are there any questions, Mr. Fulton?

Mr. FULTON. General, we are glad to see you here today, because we know of your distinguished record and your forward-looking approach to these matters of space.

Is not the problem of space the problem of the highest strategic urgency for the security of the United States?

General BOUSHEY. I agree it is, sir. I put out this one caution, though, that we don't take away our present deterrent for something 10 to 15 years in the future because we might make ourselves too vulnerable in the interim.

Mr. FULTON. So that this space program should not replace our current military security programs within the Air Force or on the ground, but should be in addition to it?

General BOUSHEY. In my opinion, sir, it should be in addition or a judicious balance.

Mr. FULTON. In order to expedite a quick moon shot, would you develop at the present time any propellents or engines of greater magnitude of efficiency and power?

General BOUSHEY. Indeed I would, sir; and this is already in the beginning stages.

Mr. FULTON. Would you favor the development of the million-pound-thrust engine at the present time?

General BOUSHEY. Yes, sir.

Mr. FULTON. How fast a program would you put on to get that?

General BOUSHEY. Personally I would try to see it through development and in the firing test stage in 5 years, sir.

Mr. FULTON. Once we had a million-pound thrust in the United States we could get up into orbit weights of considerable size, could we not?

General BOUSHEY. Yes, sir.

Mr. FULTON. I was very much interested in your comment on the fact that once we leave the earth's air and atmosphere that there might then be a change in the vehicle's type of propellant in the so-called moon shot.

General BOUSHEY. Yes, sir.

Mr. FULTON. Under those circumstances, would you then recommend that the United States Government proceed with an accelerated program of ion propellants investigation and study?

General BOUSHEY. Yes sir. I believe other witnesses have already testified about the utility of ionic propulsion.

Mr. FULTON. But you do feel it is worthwhile and it should be gone into for use in the outer atmosphere and space?

General BOUSHEY. Immediately, sir, if for no other use than attitude control alone.

In other words, for precise observation or even for reentry the vehicle must be alined very precisely.

This can be done most efficiently and effectively by ionic propulsion and in a relatively short time period.

Mr. FULTON. One of the good things about ionic propulsion, even though it is slow to start, is that it has continuous acceleration, does it not. It has very little weight because of the fuel?

General BOUSHEY. Yes, sir; my understanding is that it is the most efficient means of propulsion today although the propulsion rates are very low, a thousandth of a G acceleration.

Mr. FULTON. At a distance of 20,000 to 25,000 miles from the earth, even a few tons of material, or substance, at the earth's surface, would be only 1, 2, or 3 pounds in weight?

General BOUSHEY. Yes, sir; but the mass would still be there.

Mr. FULTON. That is my next point.

Do you feel that the mass is a complete obstacle to the use of ion propulsion the way some people have said, that we might have to have a sail with 50 million square feet of surface which would increase the mass tremendously in order to have ionic propulsion?

General BOUSHEY. Are you referring to photon propulsion, sir? The sail makes me say photon.

Mr. FULTON. Yes, sir.

General BOUSHEY. Yes, sir; I have heard very large areas are required for photon propulsion, or the pressure of light.

Mr. FULTON. Actually, what I am bringing up is this: When we have a large mass outside the earth's atmosphere and we talk of the ionic or photon propellent, which is small in relation to the mass, and a small power, is the mass itself enough to stop us on either ion or photon propulsion?

General BOUSHEY. I cannot see it, myself, sir, why there would be any limitation.

Could I give a little example?

Mr. FULTON. I would like it.

General BOUSHEY. I used to work with a technician. I would always propose a number of "out in the blue" ideas and try them on him for size. He always had a good expression. He said, "Colonel, (f) equals (ma). Force equals mass times acceleration." This is his way of saying you cannot beat the laws of nature.

In your case "(f) equals (ma)", force equals mass times acceleration. I can't see why mass should be any hindrance over the use of small acceleration.

Over a period of time we could develop tremendous velocities.

Mr. FULTON. On the exit from the earth's atmosphere we would have to go at a considerable speed in order to get out. Then, if the ion or photon propellent took over, it would mean merely to maintain the speed which is almost coasting.

General BOUSHEY. Yes, sir.

Mr. FULTON. So that we might need a little force in relation to the mass. Is that not right?

General BOUSHEY. Yes, sir.

I don't know if you are aware of some proposals to use ionic propulsion to power gigantic freighters of the future to the vicinity of Mars or Venus. These might take many, many years, but who cares if you are only transporting supplies? You can do it most efficiently.

Mr. FULTON. With earth's gravity accelerating at 32½ feet per second, it would not take many seconds to get a terrific speed, if we had no drag.

General BOUSHEY. That is quite correct, sir.

Mr. FULTON. Then, with either photon propellent or ionic propellent, while the speed and power might be slow to begin with, with a continuous acceleration for maybe 1 to 10 years, we might even be approaching half the speed of light?

General BOUSHEY. So I understand, sir.

Mr. FULTON. So that my final conclusion is that you would recommend proceeding with study and investigation of both ion propellent as well as photon or light propellent?

General BOUSHEY. Indeed I would, sir.

Mr. FULTON. There have been some questions raised by several witnesses that photon propellent was not even worth a study. Do you disagree with that?

General BOUSHEY. I am not sure I understand the term "photon propellent," sir. My understanding, and I could be quite wrong——

Mr. FULTON. Photon engine, we call it.

General BOUSHEY. It is a light-pressure engine. A propellent would merely be used to convert the energy of the fuel into some light condition or at least develop a light pressure.

Mr. FULTON. Being a Navy man I was using propellent in the nature of a propellent which pushed. I have asked that a glossary be prepared of all these scientific terms so that we would have an overall dictionary of these scientific terms for scientists, military, laymen, and Congressmen.

Do you agree that should be done?

General BOUSHEY. Yes, sir; very much. There has been an attempt at this, a small start by the Air University, but this is only within one service.

Mr. FULTON. We ought to have an official Government glossary or dictionary of official scientific terms so that we can have a place to look to see what we mean by our words.

General BOUSHEY. Yes, sir. If you don't have a little copy of this glossary of astronautic space terms, I will be glad to give you one. It is the Air Force glossary only. I agree we need to agree on what we are talking about, the definitions.

Mr. FULTON. How can we presently translate foreign languages, particularly Russian, into a scientific jungle, such as we have in the words on space, when many people do not use the words in the same context?

General BOUSHEY. That is quite true, sir. Like the title of the TV program Sunday, Blazing Roads to Stars. I am not sure of the translation, if they meant they were blazing as you blaze a highway through a mountain, or they were blazing because of the rocket flame. That is an example of what you are talking about, sir.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. General, before we get to ion or photon propulsion, is it not pretty generally agreed that nuclear propulsion could come quicker?

General BOUSHEY. I am not sure in my own mind it could, sir; and they are so vastly different, whether they could or could not, I think we have to go ahead with both.

It would be very difficult to have a human in the environment near nuclear propulsion while it is operating.

Mr. KEATING. That is the great difficulty with nuclear propulsion?

General BOUSHEY. One; yes, sir.

Mr. KEATING. That has not yet been solved?

General BOUSHEY. No, sir, but even with nuclear propulsion I believe Mr. Fulton points out that ionic propulsion is more efficient as far as specific impulse goes.

Mr. FULTON. I agree with you.

Mr. KEATING. I want to see if I can get this straight in my own mind. You are talking here to most of us, who are not scientists, about this refueling process in outer space which intrigues me considerably.

Now, the part that particularly intrigues me is how the refueling vehicle and the refueled vehicle marry up out there in outer space.

When they get there in order to get into orbit they both have to be going 18,000 miles an hour.

General BOUSHEY. Yes, sir; depending on the altitude of the orbit.

Mr. KEATING. If you can get them both in line with each other, then it is just as if they are both standing still.

General BOUSHEY. That is right.

Mr. KEATING. If I oversimplify this you tell me so, but that is the way it strikes me.

In other words, the earth is going around pretty fast right now, and you and I are going with it, but we are going at the same rate, so we are here stationary, vis-a-vis each other. Is it the same principle when you get out there in outer space?

General BOUSHEY. I think it is, sir, but to get exactly into the same plane of orbit and to precisely adjust speeds is one reason I felt that a human operator making the rendezvous and refueling will be necessary.

There is one helpful thing. As you go farther and farther out in orbit the velocity decreases. So if you can visualize joining up as in formation, which we do in the air frequently, you would travel on the inside orbit and then pull up.

In other words, you go up into a larger circle and thus kill your speed and join up. I think you can do the same thing from orbit, coming in at a lower orbit altitude and then thrusting outward, which would slow you down.

How it will be done, I will not predict, but there are certain physical laws that help rather than hinder.

Mr. KEATING. You would have to use electronic equipment in connection with locating this satellite that you are trying to marry up with.

General BOUSHEY. Yes, sir. I hope the rough rendezvous could be guided from the ground. Then as the man came in proximity to this big refueling satellite, or you might say space fuel truck, then he would take over with his self-contained electronic instruments and effect the final rendezvous and refueling.

Mr. KEATING. In mentioning these ways, of course, the advantage of the refueling arrangement—indeed, the necessity of refueling if you use present fuels—is apparent because you just could not get off the earth with any conceivable amount of power filled with liquid propellent stuff to go to the moon.

Do I understand that would take 900,000 pounds that you would have to propel into space to do that?

General BOUSHEY. No, sir. I cannot give you an exact figure.

Mr. KEATING. But it would be an astronomical figure?

General BOUSHEY. No, sir; I think it would be a fairly modest figure Say the final payload that is going to return to the earth is 15,000 pounds. You must work the problem backward.

This 15,000 pounds then has to get into orbit around the earth before it reenters. Then it has to get from the moon's orbit down to the refueling orbit around the earth.

Then it gets from the orbit of the moon to the moon's surface, back from the moon's surface, back to the fuel tank it left off in orbit.

Then it goes from that orbit back to the first refueling orbit and back to the earth.

In that way you can calculate what the total takeoff weight must be.

Mr. KEATING. It would have to drop 2 or 3 engines on its way?

General BOUSHEY. It could drop off engines or fuel tanks, whatever you have.

Mr. KEATING. You could drop 6 or 8 if you had them?

General BOUSHEY. Yes, sir.

I quote a figure I saw close to a million pounds for one vehicle which was shown which might do the trick. I would hate to be quoted that that is the minimum size or that is the maximum size. It just gives an order of magnitude, sir.

The CHAIRMAN. Will the gentleman suspend right there.

The Chair recognizes Mr. Fulton to present a very distinguished guest.

Mr. FULTON. We have with us today Dr. J. C. Warner, president of the Carnegie Institute of Technology at Pittsburgh, a scientific school with 5,000 students. He is a distinguished member of the American Academy of Science, as well as a member of the General Advisory Committee of the Atomic Energy Commission.

He has done many distinguished things and received many awards for his service in science to our country.

I am glad to welcome him on behalf of the committee and say to Dr. Warner that we are looking to schools such as the Carnegie Institute of Technology to expand in order to train this very select group of thinkers who are going to be necessary for solving these problems of outer space.

The CHAIRMAN. We are glad to have you with us, Dr. Warner.

Dr. WARNER. Thank you very much.

The CHAIRMAN. All right, Mr. Keating.

Mr. KEATING. I realize that we can conceive, at least now that we have come to Washington, we can conceive of what a million means.

You think that something perhaps in the neighborhood of that weight, when it left the ground, could project a 15,000-pound payload to the moon?

General BOUSHEY. Yes, sir; as I have outlined. If you would like, sir, I could have some calculations run by our technicians and give you a more precise answer.

Mr. KEATING. I think in this record it might be well, because that is the only thing you can do today with existing hardware.

You do not have the nuclear problem solved; you do not have the ion problem solved; you do not have the photon. You could not do that today, but that is the first thing you could aim at doing, probably, using present propellents.

General BOUSHEY. Yes, sir; and pure ballistic type of liftoff.

If you want to combine and perhaps get a hybrid, you might take advantage of aerodynamic lift as well.

I have also seen some reported pictures of Russian vehicles that sprout wings to help in the exit.

Mr. KEATING. After they get up there, they sprout them?

General BOUSHEY. Yes, sir. They could start from the ground as an air breathing vehicle. There are many ways to do this. I would not say that the ballistic million-pound approach is the best way. There might be better, cheaper, and smaller ways to do the same job.

Mr. KEATING. What thrust would it require to put up a million pounds of weight?

General BOUSHEY. In orbit, sir?

Mr. KEATING. We are talking about this million pounds with a 15,000-pound payload that returns to the earth.

General BOUSHEY. I don't know, sir. I would hate to give a quick guess.

Mr. McDONOUGH. Is there a definite ratio on thrust or weight?

General BOUSHEY. Yes, sir, 1.2 or 1.3 is a ratio on a purely ballistic way of doing it, but I feel we are not smart enough to say that is the only way we can do it.

I think we can do it better and more effectively in the future. Getting to your question, ionic propulsion would not be any good getting you from the ground. That is quite true.

But if you are in the airless surface of the moon, which to all intents and purposes is a pretty good vacuum, you might be able by catapulting with an electric catapult or something, to get the vehicle at a high enough speed.

I think escape speed is 1.7 miles per second, from the surface of the moon as against 7 miles per second from the earth. Then you might take over with photon, or I prefer ionic, propulsion and go on from there.

It might be a very small vehicle, sir.

Mr. KEATING. It looks as if eventually that is what you would have to do?

General BOUSHEY. Yes, sir.

Mr. KEATING. Now, I want to be sure I have in my mind the great advantages which you foresee in viewing the earth from the moon. Did I understand that at 22,000 miles out from the earth you could see a 17-foot object on the earth?

General BOUSHEY. That is a conservative estimate. You could probably see smaller than that.

Mr. KEATING. So as to discern what that object was?

General BOUSHEY. No, sir; that is the limit of detection. You might need a little larger object to decide what it was.

It not only is a matter of shape, but it is a matter of light contrast as well. This is why photo interpreters use the shadows to identify objects more than the resolution or shape of the object itself.

Mr. KEATING. Do you mean you could do that with existing equipment?

General BOUSHEY. With a 200-inch telescope, which has been in operation at Mount Palomar for 15 years or more, if this were placed in a 22,000 mile stationary object, this is a resolution you could see and this is a conservative estimate.

Mr. KEATING. Now, 22,000 miles up in space is a little high, even for this committee. Suppose you are only two or three hundred miles out in space, or, say, 500 miles, how small an object could you see?

General BOUSHEY. I think the figure turned out to be about 1¾ feet. I referred to it as approximately 2 feet from a 500-mile orbit. That is using the 40-inch mirror, sir, not the 200-inch.

Mr. KEATING. Would it be practical to use a 200-inch mirror?

General BOUSHEY. It might be, sir, but the rate at which this satellite would be traversing the surface of the earth might cause your rate of traverse, your image speed to be so high you could not compensate for it.

You are looking at a pretty small patch of ground with a great big mirror. Then I imagine this big mirror, even in space where you don't have the disadvantages of gravity, it would be pretty hard to put it up there and keep it there.

Mr. KEATING. At 500 miles up you could see a 2-foot object sufficient to identify it?

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General BOUSHEY. I did not say identify it. It might take twice that size to identify it, but it could be detected.

Mr. KEATING. It still is pretty staggering. You think a 4-foot object could be identified from 500 miles?

General BOUSHEY. I wanted to sound somewhat conservative, sir, but the way it was told to me by a physicist who, I believe, is very expert in his field, you could see a man, you could detect his arms and legs, but you could not tell who he was.

Mr. KEATING. From 500 miles?

General BOUSHEY. Yes, sir.

Mr. KEATING. You could tell it was a man?

General BOUSHEY. Yes, sir.

Mr. KEATING. I do not mean a man or woman.

General BOUSHEY. No, sir You could probably tell it was not a four-legged beast.

Mr. KEATING. You could tell it was a two-legged animal at 500 miles?

General BOUSHEY. So I have been told, sir. I went to the trouble before appearing before your committee, Mr. Chairman, to check with four astronomers who have enviable reputations. I have used the most conservative of any of their estimates as to what is possible with optics.

I am not an expert in optics, myself, sir

Mr. KEATING. So that you could certainly tell at 500 miles up the nature of an entire building, as to whether it was a factory or house, or what it was?

General BOUSHEY. Provided it was not during a condition of cloud cover or night

Mr. KEATING. I am assuming good conditions.

General BOUSHEY. Yes, sir. These are under the best of seeing conditions, these figures I have quoted.

Mr KEATING. I know I have displayed great ignorance in some of my questions, but I am starting from scratch on a lot of this.

Why do you not encounter the same difficulty in looking down at earth that you would on the earth looking up 500 miles into the air?

General BOUSHEY That little card was supposed to show why.

Mr. KEATING. I did not get that. In other words, why is not that cloudy result achieved whichever way you look?

General BOUSHEY Maybe a homely example, sir, if you look through a pair of binoculars and your hand has tremors, if affects the image. If you had the big binoculars over there and it had the same tremors, it would not affect the image as much.

That is the way I explain it to myself, but again, I am not an optical expert, sir.

Mr KEATING. Thank you, General, you have been very helpful.

I want to compliment you on your testimony, particularly on the simplicity of it and the down-to-earth character of it, which is very helpful.

General BOUSHEY. Thank you, sir.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Continuing Mr. Keating's questions about an object, how accurately can we reflect an object on the moon from a satellite with apparatus on the satellite and reflecting back what it says?

General BOUSHEY. Are you talking about optical viewing, or reflecting by some electronic means?

Mr. McDONOUGH. By electronic means.

General BOUSHEY. Sir, I cannot help you on that. I do not know much about that area.

Mr. McDONOUGH. I have no other questions.

General BOUSHEY. I am sorry, sir, that is something I hesitate to answer.

The CHAIRMAN. I do not know of any better answer than a frank one.

Mr. Metcalf.

Mr. METCALF. You mentioned in this projected trip to the moon that you are going to orbit around the moon.

General BOUSHEY. Yes, sir. Not I.

Mr. METCALF. You and Admiral Rickover are going to stay home. That space craft of yours is going to an orbit around the moon. Will you tell me something about orbiting around the moon? What is the distance at which an orbit can be reached and what is the speed?

General BOUSHEY. I have heard no limit to how close a vehicle can orbit around the moon. It depends on the traces of atmosphere and how accurate the orbit is around the moon.

If it were completely circular and the moon is absolutely circular and the high craters did not get in the way, I guess you could do it at an altitude of several hundred feet above the moon.

Mr. METCALF. What would the speed have to be?

General BOUSHEY. I have not worked that out. I can furnish it to you later, sir.

Mr. METCALF. You are going to have a satellite with another satellite orbiting it?

General BOUSHEY. I do not see any point in orbiting so close to the surface of the moon. What would be the reason?

Mr. METCALF. I do not know. I was wondering how far out. I had no idea you could orbit within a hundred feet. I was thinking of an orbit of 50 or 100 miles.

General BOUSHEY. Could I give you an example that might help you, sir?

Mr. METCALF. Yes.

General BOUSHEY. The diameter of the earth is roughly 8,000 miles. We are talking about a satellite orbit 150 miles from the surface of the earth.

If you drew that graphically you would have a great big earth, and then a tiny orbit altitude you could hardly see. So, relatively, we are orbiting relatively close to the earth now.

The moon is 2,000 miles in diameter. And it has no atmosphere. So I don't see any reason why you could not orbit just grazing the tops.

The CHAIRMAN. Mr. Feldman.

General BOUSHEY. Pardon me, sir, we have the answer to the question.

Colonel DILLON. The velocity of the orbit would be less than 7,750 feet per second to orbit around the moon.

Mr. METCALF. How many miles is that?

Colonel DILLON. That is a little bit more than a mile a second.

Mr. McDONOUGH. Mr. Chairman, I have one question.

You speak about no atmosphere around the moon because we find no cloudy envelope around it.

Is it possible that there is some invisible gas around the moon that we have not discovered?

General BOUSHEY. Small traces; yes, sir.

As to any appreciable quantity, I think the astronomers could answer definitely no. When a star passes behind the moon, the refraction that would take place if there were appreciable atmosphere is not observed.

Therefore, any atmosphere on the moon may lie in low crater. It may be that there are such heavy gases as argon or krypton, heavy gases that do not escape, in accordance with the laws of physics, the gravitational attraction of the moon, but if there are gases they are heavy gases only and there are only small traces in the low levels on the moon. You must recall in the daytime the temperature gets above that of boiling water so it would drive off the light gases, and at nighttime, which is 14 days, the temperature gets down to minus 240° Fahrenheit.

So gas might freeze and remain in the solid state.

Mr. McDONOUGH. Have there been any spectroscopic studies of the atmosphere surrounding the moon or any reflection on the moon which may indicate presence of certain elements?

General BOUSHEY. I don't know of any, personally, sir, I have only read the theories.

So far from my knowledge I have heard no factual evidence that any gas existed or having been detected on the surface of the moon.

Mr. McDONOUGH. We have researched our more information about the moon than any other planet; have we not?

General BOUSHEY. Yes, sir.

Mr. McDONOUGH. We know little about Mars, except at the other end of the telescope?

General BOUSHEY. That is right; and a radio telescope, both.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. General, you said that you would like to see representatives of the 3 services on this 17-man advisory board.

General BOUSHEY. Yes, sir.

Mr. FELDMAN. The NACA setup as it presently exists has a 17-man advisory board. Is that right?

General BOUSHEY. I believe you are correct, sir. I believe you know more than I do about it.

Mr. FELDMAN. And the Director is under the Board, that is, it has control, it sets the policy?

General BOUSHEY. My understanding is that Director is appointed by the Board.

Mr. FELDMAN. Is that right? And the primary duty of the NACA at the moment is to do research projects which other agencies ask them to do for them. Is that right?

General BOUSHEY. Yes, sir; and I believe also undertake those that in their opinion they should be doing themselves, not upon request.

Mr. FELDMAN. They do not build any hardware themselves. Is that correct?

General BOUSHEY. Hardware for test purposes only; not for end use.

Mr. FELDMAN. And they build them with their own facilities?

General BOUSHEY. I believe they do, sir, but they are also permitted, I think by law, to contract, if need be, and the services, of course, enter into joint arrangement with the NACA where, for example, the X15, which I am sure you know, the Air Force is funding, the Navy is funding, and the NACA is funding.

It is being built by a private contractor.

Mr. FELDMAN. Now, under the new proposal, the research takes place and the Advisory Board only acts in an advisory capacity. It can only recommend and the Director then becomes the head of the organization?

General BOUSHEY. Yes, sir.

Mr. FELDMAN. Now, if you have representatives on such an advisory board, those representatives would merely recommend, at the most, or help recommend. Is that not true?

General BOUSHEY. That is the way I understand the proposed law, sir.

Mr. FELDMAN. Now, the purpose of the liaison committee is to let the right hand know what the left hand is doing. Isn't that fundamentally the reason for it?

General BOUSHEY. Yes, sir.

Mr. FELDMAN. In the case of the Atomic Energy Commission, there is a specific provision requiring a military liaison committee. Are you acquainted with that fact?

General BOUSHEY. No, sir; I am not intimately acquainted with that, but I believe you are correct.

Mr. FELDMAN. That is the fact.

General BOUSHEY. Yes, sir; that is the fact.

I notice Colonel Armstrong, who works with the AEC, agreeing.

Mr. FELDMAN. The military liaison committee there knows precisely what the Atomic Energy Commission has in mind in connection with anything that the military might want, and vice versa?

General BOUSHEY. Yes, sir; we submit our need to them, and I believe vice versa. What they are doing is made known to us in the service.

Mr. FELDMAN. They also look to you for assistance in the event they need assistance in connection with any project that they may have in mind that involves the military.

General BOUSHEY. Yes, sir.

Mr. FELDMAN. That is a provision in the law and is required in the law.

Now, this new 17-man committee which would have, say, a representative of the military or 3 representatives of the military, could then only advise, and whether the advice was followed would be entirely up to the director.

Do you think that that type of requirement would satisfy the liaison requirements of the military?

General BOUSHEY. I have not given it much thought, sir, but quickly I would say it would, because the Department of Defense always has the recourse of going to the President, if something is not being accomplished that must be accomplished for the good of the Nation.

Mr. FELDMAN. Does that not take a lot of time?

General BOUSHEY. I imagine it would, sir, and it would have to be a pretty important thing.

Mr. FELDMAN. As compared with the other method, if you had your personal choice, which would you choose?

General BOUSHEY. I would prefer the method under which the NACA operates today, sir.

Mr. FELDMAN. Today?

General BOUSHEY. Yes, sir.

Mr. FELDMAN. But if they did not have any authority to do other than to kibitz, as Dr. Dryden put it yesterday, would your answer still be the same?

General BOUSHEY. You are comparing now to the NASA advisory committee, you might say, as compared to a military liaison arrangement that exists with the present-day AEC?

Mr. FELDMAN. That is right.

General BOUSHEY. I have not given that any thought. I don't know which would be better.

Mr. FELDMAN. We know from experience, plus the fact that we have had this body of experience with the Atomic Energy Commission, that that is functioning smoothly.

We don't know how this new arrangement would work under the new setup.

General BOUSHEY. You are correct. The NASA is new and the NACA as it presently exists and the AEC arrangement both work, and they both work effectively. We know how the NACA works; how it would work with the new arrangement we don't know.

Mr. FELDMAN. We do know that the Advisory Board has to meet only four times a year. It might meet, say, even 10 times a year, whereas the liaison committee between the military and the AEC under the AEC law is a constant, permanent body. They know exactly what is going on at all times.

General BOUSHEY. Your opinion is well taken.

Mr. FELDMAN. And it sifts or seeps down to the lowest level. Would your conclusion be any different in that hypothesis, assuming that is not the fact?

General BOUSHEY. Sir, I am in an area where I really cannot give an answer. I don't know enough about it.

Personally, the reason I made the remark, I thought the three services should be on the new NASA, is merely that it did not seem that 1 out of 17 was a proper proportion. Out of the $40 million that the military spends, a lot of it goes for space effort. That is my only basis for saying that.

Mr. FELDMAN. You would be in favor of the strongest kind of liaison. Is that right?

General BOUSHEY. Yes, sir; that is correct.

Mr. FELDMAN. In other words, if you had your choice you would choose the stronger of the two?

General BOUSHEY. Correct.

Mr. FELDMAN. And that which protected the military?

General BOUSHEY. Yes, sir.

Mr. FELDMAN. Incidentally, will you put that glossary that Congressman Fulton asked you to prepare into the record?

General BOUSHEY. This one, sir?

Mr. FELDMAN. Do you think that could be improved on in any way?

General BOUSHEY. Undoubtedly, sir. He said he already had a copy of it.

Mr. FELDMAN. I think he asked if it might be reworded and put in the record as part of your testimony.

The CHAIRMAN. Without objection, that will be made a part of the record.

(The material referred to follows.)

Interim Glossary

Aero-Space Terms

Air University
March 1958

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Personal views or opinions expressed or implied in this publication are not to be construed as carrying official sanction of the Department of the Air Force or the Air University.

Preface

This glossary of aero-space terms is published to give guidance in a specialized vocabulary that deals with space missiles, space vehicles, and the physical laws that govern them. The vocabulary involved is very rapidly developing. There are new coinages and new combinations like *destruct*, *launch pad*, and *burnout velocity;* there are also new meanings of old words. A word like *space*, for example, has acquired a meaning not previously noted when used to describe an upper region with a lower limit well within the atmosphere of the earth (see the vocabulary). Likewise, a word like *satellite* is now commonly applied to an object shown in popular magazines as resting upon a scientist's desk, gleaming with reflective paint and bristling with antennas; heretofore a satellite has had to be in orbit to be a satellite.

One thing in particular the user must understand. The data on missiles, such as *Atlas*, is from press reports. It is probably reliable, but is not official, and is offered only for general comparison.

The glossary is to be regarded as an interim affair, brought out because of the high degree of current interest in the subject of space relations. We need a broader coverage than what can now be afforded. This can be acquired, especially if the users of the glossary will send in additions and critical comments to the Editor. He is working on a more comprehensive glossary, and he welcomes widespread help.

Preface

One good way to help him is to send in a quotation that illustrates a term. Don't try to define the term yourself necessarily, although this will help; just pick out a good quotation, or concoct a sentence that will give enough context to show how you understand the term. The Editor can then compare this usage with that of other quotations.

Users of the glossary ought also to make use of a good commercial dictionary and the USAF Dictionary. Many words used in space operations are taken from aviation contexts, and as the future develops, more words and phrases are going to be introduced by Air Force people, based upon knowledge accumulated in flight through the atmosphere.

Special acknowledgements are due the following for assistance on the present interim glossary: the Commander's staff in Air University Headquarters, the Research Studies Institute, the Air University Quarterly Review, the School of Aviation Medicine, the faculty of the Weapons Course of the Air Command and Staff College, and the Ballistic System Education Division of Air University with the Ballistic Missile Division of ARDC.

WOODFORD A. HEFLIN, *Editor*

Research Studies Institute
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A

AAM *(abbr)*. 'Air-to-air missile.'

ABMA *(abbr)*. 'Army Ballistic Missile Agency.'

abort, *n*. **1.** In an operational action, an instance of a rocket missile or vehicle failing to function effectively and not achieving the objective plotted for it. **2.** A rocket missile or vehicle that so fails.

In sense 1, an abort may take place at any point from the ignition action to the end of the trajectory or other objective. An abort is distinguished from a test failure (which see).

abort, v. *intr*. Of a rocket missile or vehicle: To become an abort.

absolute zero. The temperature at which all thermal motion or heat action ceases, approximately −273.16° C, −459.69° F, 0° K, and 0° R.

acquisition and tracking radar. A radar set that locks onto a strong signal and tracks the object reflecting the signal.

Aerobee, *n*. A research sounding-rocket developed by Aerojet-General Corporation. See **sounding rocket.**

The Aerobee is a two-step rocket, the first a booster rato unit, the second a liquid rocket. Its overall length with booster is 26 feet, its diameter 1.25 feet, its weight 1,655 lbs. Unguided but stablized by a tail fin, it reaches 90 miles altitude at a speed of 2,900 mph. An advanced version, the *Aerobee-Hi*, is reported as reaching 160 miles.

aeroembolism, *n*. The formation of gas bubbles (principally nitrogen) in body tissues after exposure to conditions of low atmospheric pressure, as in high-altitude flying without benefit of a pressure suit or pressurized cabin; the illness brought on by the presence of these bubbles.

aeropause, *n*. An upper region of the atmosphere in which the atmosphere ceases to function for manned or unmanned flight.

The lower limits of the aeropause vary according to the use to which the atmosphere is put, its upper limits recede as man advances in knowledge of aeromedical and aeronautical design.

aero-space, *a*. Of or pertaining to the earth's envelop of atmosphere and the space above it, the two considered as a single realm for activity in the launching, guidance, and control of ballistic missiles, earth satellites, dirigible space vehicles, and the like.

The upper limits of the aero-space realm recede upward as technology and science bring it under greater control.

AFBMD *(abbr)*. 'Air Force Ballistic Missile Division.'

AFCRC *(abbr)*. 'Air Force Cambridge Research Center.'

AFFTC *(abbr)*. 'Air Force Flight Test Center.'

AICBM *(abbr)*. 'Anti-intercontinental ballistic missile.'

aiming error. In missilry, an error that results from a miscalculation in such matters as longitude or latitude, distance, speed, re-entry deflection, or the like. Cf. **circular probable error.**

air, *n.* **1.** The mixture of gases in the atmosphere. **2.** The element that gives lift to aircraft, or offers resistance to objects that move through it. **3. a.** The region above and around the earth, including the atmosphere and the space beyond, subject to control by air or space vehicles, in contradistinction to land and sea. **b.** *Restrictive.* That part of this region that includes the atmosphere up to its effective upper limits, but not outer space. See **effective atmosphere.**

A strong trend has set in to restrict the word *air* in many contexts of sense 3 to the meaning set forth in sense 3b. This leads to considerable ambiguity in combined forms already in use, such as *air attack, air control, air force, air power, air vehicle, air warfare,* and *air weapon,* which carried broad meanings reasonably understood so long as the capability for space travel had not made it necessary to distinguish between flight through the air (i.e., the atmosphere) and flight through outer space. Space capability, however, has automatically given restricted meanings to these terms, making it necessary to avoid ambiguity by introducing changes in phraseology. See, for example, the definition of *continental air defense,* wherein the necessity is clear for using *air attack* in a restricted sense.

air-breather, *n.* A missile, like the Snark, propelled by fuel oxidized by intake from the atmosphere.

aircraft rocket. A rocket missile specially designed to be carried by, and launched from, an airplane.

Air Force Ballistic Missile Division. (AFBMD) A division of Headquarters ARDC, established as a field organization at Inglewood, California, to command and control the development of an operational intercontinental ballistic missile.

Air Force Cambridge Research Center. (AFCRC) See note.

This is an ARDC center, located at Lawrence G. Hanscom Field, Massachusetts, which conducts research and development in electronics, geophysical sciences, balloon technology, and human engineering.

Air Force Flight Test Center. (AFFTC) An ARDC center at Edwards Air Force Base: See note.

This center accomplishes functional flight tests of complete, manned aircraft weapon systems, conducts engineering evaluation flight tests of aircraft and power plants, makes static firing tests of missile power plants.

Air Force Missile Test Center. (AFMTC) A major subdivision of the Air Research and Development Command with headquarters at Patrick AF Base, Florida.

The AFMTC is responsible for the missile launching site at Cape Canaveral.

Air Force Special Weapons Center. (AFSWC) An ARDC center at Kirtland AF Base, New Mexico.

This center develops and tests atomic weapons and systems components; and evaluates personnel hazards associated with their employment.

airframe, *n. Specif.* in reference to rockets: The bodily structure of a rocket missile or rocket vehicle that supports the different systems and subsystems integral to the missile or vehicle.

The airframe includes the framework and outer skin, likewise the nose cone and combustion chambers so long as they remain attached to the vehicle.

Air Research and Development Command. (ARDC) A major air command of the USAF charged with carrying out research and develop-

ment in basic and applied science and in human engineering in order to provide for the requirements of the USAF.

air weapon. **1.** A weapon used by an air force, employed above the earth, either within the atmosphere or in outer space. **2.** *Restrictive.* Such a weapon essentially used within the confines of the atmosphere.

Use of the term *space weapon* as a differentiating term automatically gives a restrictive meaning to *air weapon* See **air,** *n*, note

albedo, *n.* The ratio of light reflecting from an unpolished surface to the light falling upon it.

This term is used esp in reference to light reflected from the moon or the planets

alcohol, *n.* Ethyl alcohol (C_2H_5OH) or methyl alcohol (CH_3OH), used with liquid oxygen as a bipropellant. See **specific impulse,** note.

Ethyl alcohol and liquid oxygen were used in the German V-2

Alpha, *n* The Explorer. So named by IGY American scientists. Also called '1958 Alpha.'

In 1957, Sputnik I was called '1957 Alpha,' Sputnik II '1957 Beta'

analogue computer. A computing machine that works on the principle of measuring, as distinguished from counting, in which the measurements obtained, as voltages, resistances, etc., are translated into desired data. See **digital computer.**

Analogue computers range from the relatively simple devices of the slide rule or airspeed indicator to complicated electrical machines used for solving mathematical problems Radar and gun directors lean heavily upon this type of computer.

anoxia, *n. Medicine.* An absence of oxygen in the blood, cells, or tissues of the body. Often confused with hypoxia (which see).

antimissile missile. An explosive missile launched to intercept and destroy another missile in flight.

apogee, *n.* **1.** That point in an elliptical orbit of an earth satellite at which the distance is greatest between the orbiting body and the earth. Cf. **aphelion,** *n.*, **perigee,** *n.* **2.** The point of greatest distance from the earth in the trajectory of a ballistic missile.

Since the orbit of an earth satellite is elliptical, its apogee (sense 1) is 180° from the perigee through the center of the earth. See **ellipse,** *n*

aphelion, *n.* That point on a planet's or comet's orbit most distant from the sun. Cf. **ellipse,** *n.*

The earth's aphelion is about 94,500,000 miles from the sun

ARDC *(abbr).* 'Air Research and Development Command.'

ARDC center. One of the several major subdivisions of ARDC directly subordinate to Headquarters Air Research and Development Command See entries on page 2 for examples of ARDC centers

Aries, *n.* *The first point of Aries,* the vernal equinox.

Army Ballistic Missile Agency. (ABMA) An agency of the US Army, with research and development facilities at Huntsville, Alabama, charged with research and development of rocket missiles and rocket vehicles.

ARPA *(abbr).* 'Advanced Research Projects Agency.'

The ARPA was established by Secretary of Defense McElroy to press the development of antimissile missiles, space vehicles, and other related technical equipment, its first director, appointed in February 1958, was R. W. Johnson, a vice president of General Electric.

artificial earth satellite. A manmade earth satellite, as distinguished from the moon. Usually called 'earth satellite.'

ASM *(abbr).* 'Air-to-surface missile.'

astrionics. The art or science of adapting electronics to space flight.

astrobiology, *n.* A branch of biology concerned with the discovery or study of life on planets.

astronaut, *n.* One concerned with flying through space, or one who navigates through space. See **astronautics,** *n.*, note.

astronautics, *n.* **1.** The art, skill, or activity of operating space vehicles. **2.** In a broader sense, the art or science of designing, building, and operating space vehicles.

Because the prefix *astro* means 'star,' this term is, or may be, considered not wholly acceptable as defined. The term *spationautics,* however, has not been widely adopted

astronomy, *n.* The science concerned with spatial bodies, their magnitudes, motions, constitution, and interrelations.

Atlas, *n.* An AF ground-to-ground ICBM developed by Convair. Also called the SM-65.

atmosphere, *n.* (atm) **1.** The body of air which surrounds the earth, defined at its outer limits by the actual presence of air particles but in such few numbers that collisions between them are so rare as to make the force of gravity the only means of keeping them associated with air particles at lower altitude. **2.** The effective atmosphere (which see).

In sense 1, the atmosphere is usually considered to consist of different stratums or spheres, the last extending to 1,000 miles or more above the earth. From one standpoint these are the troposphere, the stratosphere, and the ionosphere, from another the lower atmosphere, the middle atmosphere, and the upper atmosphere. But these same spheres, or other spheres differently conceived, may have properties that make for use of other names, as those of *chemosphere, isothermal region, ozonosphere, exosphere, ecosphere, mesosphere,* and *thermosphere.* See separate entries

Temperatures vary in the atmosphere from a standard of 58° F at sea level to 40° F at 5,000 feet, 23° F at 10,000 feet, –13° F at 20,000 feet, –39° F at 30,000 feet, –68° F at 40,000 to 100,000 feet, etc, to an estimated 4,000° F at 2,112,000 feet or 400 miles These temperatures, sometimes reported by the Rankine scale (which see), are relative to the air particles or other objects in the stratums that absorb heat. Empty space between particles are without heat.

Sonic speeds also vary with altitude—1,120 ft/sec at sea level, 1,040 ft/sec at 20,000 feet, 973–975 ft/sec in the stratosphere, 1,430 ft/sec at 400,000. Above this (75 miles), sonic speed is without practical meaning because of the rarity of air particles.

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atmospheric refraction. Refraction of light from a distant point by the atmosphere, caused by its passing obliquely through varying air densities.

attitude, *n.* The in-flight position of a missile or other flying body described by reference to its inclination about one or two of its three axes, the longitudinal, the horizontal, and the vertical.

auntie, *n.* Also **anti.** Slang for 'antimissile missile.'

B

B-52 Defense. An AF air-to-air missile for use in strategic air operations, in development by General Electric.

ballistic condition. A condition affecting the behavior of a missile or vehicle in flight.

Ballistic conditions include the velocity, weight, shape, and size of the missile or vehicle, likewise the density and temperature of the ambient element, and the rotation of the earth

ballistic missile. *Specif.* Any missile guided during powered flight in the upward part of its trajectory that becomes a free-falling body in the latter stages of its flight toward its target.

A ballistic missile is an assembly of a number of interconnected and interacting systems and subsystems The warhead is detonated at a predetermined target by a fuzing system, the velocity and position of the vehicle during powered flight is regulated by a guidance system so as to achieve a correct trajectory before thrust cutoff; attitude stability during powered flight is maintained through a control system, electric power is provided by an accessory power subsystem, propulsion is developed through a propulsion system, monitoring equipment is provided to furnish data from test flights, and the airframe is built to support everything in the missile. The missile, at every stage in its performance, is dependent upon a precisely calculated interaction of the systems it incorporates.

Ballistic Missiles Office. (BMO) An office of Headquarters Air Materiel Command established at Inglewood, California, so as to provide a streamlined logistics system for IRBM's and ICBM's. Cf. **AFBMD** *(abbr).*

ballistic trajectory. That part of a missile trajectory traced after the propulsive force is cut off.

bioastronautics, *n.* Astronautics considered for its effects upon animal or plant life.

biodynamics, *n.* The study of the motions of bodies and of the forces acting upon bodies in motion, or in process of changing motion, as these motions or forces affect life.

biosatellite, *n.* A satellite designed to carry an animal or plant, or a satellite that carries an animal or plant.

The word *animal* as used here includes man

biosphere, *n.* That part of the earth and its atmosphere in which animals and plants live.

bipropellant, *n.* A liquid rocket propellant that consists of a liquid fuel and a liquid oxidizer each separated from the other until introduced into the combustion chamber; also either the fuel or the oxidizer before being brought together.

bird, *n.* A figurative name for a missile, earth satellite, or other inanimate object that flies.

block house. A reinforced concrete structure, often built underground or half underground, and sometimes dome-shaped, to provide protection against blast, heat, or explosion during missile launchings or related activities

BMD *(abbr).* Air Force 'Ballistic Missile Division.' In full, AFBMD.

BMO *(abbr)* 'Ballistic Missiles Office'

boattail, *n.* The cylindrical section of a ballistic body that continually decreases in diameter toward the tail to reduce overall aerodynamic drag.

boiling, *n. Medicine.* With respect to body fluids: Profuse vaporization that occurs at 47 mm or less of mercury.

Bomarc, *n* An AF ground-to-air delta-winged missile developed by Boeing. Also called IM–99.

The missile in its new version is reported to be 47 feet in length, 18 feet in span, 4½ tons in weight, with a speed greater than mach 2, and a range of 250 miles plus Powered by solid rocket motors, it is guided by radar or by radio command An earlier version, 66 feet in length, was launched by booster rockets, at mach 1, two ramjets mounted beneath the wing took over

booster rocket. 1. A rocket motor, usually a solid rocket, that assists the normal propulsive system of a rocket or air vehicle in some phase of its trajectory or flight path. **2.** Also applied to a first-stage rocket, as in the Aerobee.

A booster rocket (sense 1) may be incorporated into a first-stage rocket to give added power at takeoff, or it may be a rato unit externally attached.

Bulldog, *n* A Navy air-to-surface rocket missile undergoing development by Martin

The Bulldog is expected to be a larger version of Bullpup

Bullpup, *n.* A Navy air-to-surface missile undergoing development by Martin.

The Bullpup, with a solid propellant, is reported to weigh 540 lbs, to have a range of 3 miles, and to be 11 feet in length

burnout, *n.* **1.** The event or action that marks the final combustion or oxidation of a fuel. **2.** The moment that this event takes place.

burnout velocity. The velocity of a rocket at the end of propellant oxidation.

C

CAF *(abbr).* 'Complete assembly for ferry.'

Cape Canaveral. A cape on the east coast of Florida, the site of Cape Canaveral Auxiliary Air Force Base, used as a laboratory for launching missiles or space vehicles.

The Air Force Missile Test Center operates the launching site

captive test. A static or hold-down test of a rocket engine or motor. Distinguished from a flight test.

carrier rocket. A rocket vehicle used to carry something, as in 'the carrier rocket of the first artificial earth satellite.'

CAS *(abbr).* 'Complete assembly for strike.'

CASF *(abbr).* 'Composite air strike force.'

celestial body. 1. A spatial body that exists in the heavens. **2.** *Restrictive.* Any such body exclusive of a manmade space vehicle.

This term (sense 1) includes the sun, the stars, planets, meteors, the moons, the manmade space vehicles It does not, however, include the earth from one point of view, but by transference, it is commonly used to include the earth The generic term that covers all celestial bodies and the earth is *spatial body*

Technically *celestial body* covers nebulae, but *celestial structure* is also applied to them The term is also generic for the terms *astronomic body, planetary body, satellite body,* and *meteoric body*

celestial guidance. The guidance of a missile or vehicle by reference to celestial bodies.

The missile is equipped with gyroscopes, telescopes, mechanically or electrically recorded navigational tables, computers, and other instruments and devices that sight stars, calculate positions, and direct the missile The Snark, for example, is equipped with celestial guidance.

celestial mechanics. That branch of mechanics concerned with mathematical development of postulates treating of the motions of celestial bodies.

celestial sphere. An imaginery sphere of infinite radius assumed for navigational purposes, the center of which coincides with the center of the earth.

The equator of this sphere s an extension of the plane of the earth's equator

center of mass. That point in a given body, or in two or more bodies that act together in respect to another body, which represents the mean position of the matter in the body or bodies.

The center of mass in the earth about which the moon revolves is not at the same point as the center of mass of the two bodies as it revolves about the sun.

central control. 1. Control exercised over an extensive and complicated system from a single center. **2.** The place from which this control is exercised. Often *capitalized* to designate a particular place, as in 'Central Control at Cape Canaveral, the electronic nerve center of all missile firings.'

The Central Control at Cape Canaveral is located several miles from the launch platform or pad.

C.G.S. *(abbr).* 'Centimeter–gram–second.'

This abbreviation designates a system in which the unit of length is the centimeter, the unit of mass is the gram, and the unit of time is the mean solar second Used, for example, in defining the constant of gravitation

chemosphere, *n.* A stratum of the atmosphere considered to begin at approximately 20 miles and to extend to 50 miles above the earth, marked for its photochemical activity.

By some meteorologists, the chemosphere is considered to be an extension of the stratosphere

circular probable error. (CEP) In missilry, a probable error used as a factor in determining the probable damage to a target expressed in terms of the radius of a circle which would include half of the missile strikes of missiles aimed at the center of the circle.

cislunar, *a* Of or pertaining to space between the earth and the orbit of the moon, or to a sphere of space centered on the earth with a radius

equal to the distance between the earth and the moon.

closest approach. The place or time at which two planets are nearest to each other as they orbit about the sun.

cluster, *n. Specif.* Two or more solid rocket motors bound together so as to function as one propulsive unit.

coasting flight. The flight of a rocket missile or vehicle between burnout or thrust cutoff of one stage and ignition of another, or between burnout and summit altitude or maximum range (if constrained to move along a straight line).

command destruct signal. A radio signal that detonates an explosive in a rocket missile or vehicle so as to destroy it.

composite, *a.* Of a force: **a.** Having or operating different kinds of equipment, as bomber aircraft and ballistic missiles. **b.** Made up of dissimilar elements, as of two or more services.

ConAD *(abbr).* 'Continental air defense.' Cf. **NorAD** *(abbr).*

console, *n.* A basic instrument control panel usually mounted on a large tablelike piece of equipment with a slanting top, and used as a 'go-no-go' control for the launch of a rocket or for its destruction.

constant of gravitation. The acceleration that results from the attraction of a unit of mass at unit distance, determined by Heyl in 1942 to be $6.673 \times 10 \times 10^{-8}$ in C.G.S. units. See **C.G.S.** *(abbr).*

constellation, *n.* **1.** Any one of the arbitrary groups of fixed stars—some 90 now recognized. **2.** A division of the heavens in terms of any one of these groups.

continental air defense. A coordinated defense of the continental United States against air or missile attack. Cf. **air,** *n.*, note.

The defense is coordinated as among the ground, sea, and air forces, and civil defense authorities

control, *n. Specif.* **1.** The power exercised mechanically, electrically, or electronically over a rocket vehicle or rocket missile during the period of its launching and usually during a limited or extended period of its flight; the exercise of this power. **2.** Attrib., as in *control panel, control room,* etc.

The exercise of control is usually a coordinated procedure involving the use of many technicians

control system. A system in a ballistic or guided missile that serves to maintain attitude stability during powered flight and to correct deflections caused by gusts or other disturbances.

Although distinguished from the guidance system, and the responsibility of a separate research and development group, the control system uses certain devices in common with the guidance system, such as jet vanes and swiveling engines.

Cooke Air Force Base. An AF base associated with Camp Cooke, Lampoc, California, used for training missile units and being developed as a missile test launching site.

coriolis force. A deflecting force exerted by the rotation of the earth upon any object in motion, diverting the object to the right of velocity in the northern hemisphere, and to the left in the southern.

This term is named after a French mathematician who detected it, Gaspard Gustave de Coriolis (1792–1843).

Corporal, *n.* An Army ground-to-ground liquid rocket missile developed by Firestone.

This missile is said to be 40 feet long or longer, weighing 6 tons, with a speed of mach 3 and a range of 100 miles It is an outgrowth of the Wac Corporal (which see).

Corvus, *n.* A Navy air-to-surface solid propellant rocket missile undergoing development by Temco.

cosmic ray. Any ray of high penetrative power produced, according to tentatively accepted theory, by transmutations of atoms in interstellar space.

These rays bombard the earth and other objects n space, in the atmosphere they cause ionization

cosmos, *n.* The totality of the observed and postulated physical whole, conceived as an orderly and harmonious system.

The Greek word *kosmos* means order or harmony.

count-down, *n.* In the final make-ready for the launch of a rocket missile or vehicle, the action of checking each system or subsystem one after the other, using a count, e.g., 'T minus 60 minutes,' in inverse numerical order so that the count narrows down at the end to 4-3-2-1-*zero, minus 1, minus 2,* etc, during which time 'the button is pressed,' i.e., the propellant is ignited.

The count-down normally takes, in the present state of the art, considerable time to effect—sometimes several hours.

D

Dart, *n.* An Army ground-to-ground solid rocket antitank missile made by Utica-Bend of Studebaker.

The Dart is said to be 5 feet long, with a speed of 600 mph and a range of 2 miles

declination, *n.* In astronomy and celestial navigation, the angular distance of a celestial body from the celestial equator measured through 90° and named 'north' or 'south' as the body is north or south of the celestial equator measured on an hour circle.

destruct, *n.* The deliberate action of detonating or otherwise destroying a rocket missile or vehicle after it has been launched, but before it has completed its course. Said of friendly missiles esp. during test flights.

Destructs are executed when the missile gets off its plotted course or functions in a way as to become a hazard

deterrent, *n.* That which deters, esp a force in-being recognized by an aggressor nation to have such retaliatory power as to make the cost of aggression unacceptable. Said of a bomber force or a missile force. Hence, **deterrent force.**

device, *n* (dv) A mechanism that works to serve a particular purpose. Used esp. as the second element in combinations, as in *rocket device, satellite device,* or *atomic device.*

Diamond Back. A Navy air-to-air missile, still in the research and development stage under Navy Ordnance.

digital computer. A computer that works on the principle of counting, as distinguished from measuring. See **analogue computer.**

Digital computers make up a family of computers, ranging from the abacus to the business-office adding machine, to electrical relay computers as used in telephone exchanges, to the complex electronic calculators, such as Eniac Electronic computers use either a decimal or binary system of notations

Doppler, *n* [Christian *Doppler* (1803–53), a German mathematician] Used attrib. or in combination: See note

Doppler drift, the drift of a missile as determined through use of Doppler's principle by means of radar, *Doppler effect,* the apparent change in the frequency of vibrations, as of sound, light, or radar, when the observed and observer are in relative motion to one another; *Doppler's principle,* a principle of physics that, as the distance between a source of constant vibrations and an observer diminishes or increases, the frequencies appear to be greater or less, *Doppler radar,* a radar that makes use of the fact that the return signal shifts in carrier frequency by an amount proportional to the velocity with which an object, such as a missile, is moving away from, or toward, the radar, measurement of the shift being itself a measurement of the velocity of the moving object, *Doppler shift* a shift of a luminous body's lines in a spectrum toward the red indicating an increase in distance

Dove, *n.* A Navy air-to-surface solid propellant rocket missile developed by Eastman.

According to press reports, the Dove homes upon its target by radar

dry-fuel rocket. A rocket that uses a mixture of fast-burning power. Used esp. as a booster rocket.

dry run. A practice exercise or rehearsal esp. observed in preparation for a rocket launching, usually several times.

dry weight. The weight of a rocket vehicle without its fuel. Cf. **takeoff weight.**

This term appropriate esp for liquid rockets, is sometimes considered to include the payload

Duck, *n* An AF air-to-air missile still in research and development by Fairchild.

E

earth, *n* **1.** The planet we inhabit including its atmosphere. **2.** This planet without its atmosphere, 7,900 miles in diameter at the poles, 7,927 at the equator, 3,959 miles mean radius.

earth satellite. A body that orbits about the earth; *specif.,* such a body placed in orbit by man, otherwise called an 'artificial earth satellite.'

ebullism, *n. Medicine.* The formation of water vapor bubbles in the tissues brought on by boiling of body fluids.

eccentric, *a* Of an orbit· Deviating from the line of a circle so as to form an ellipse. Hence, **eccentricity,** *n.*, the state or degree of being eccentric, expressed by the difference of greatest and least distances between the two centers of mass, divided by the sum of the greatest and least distances

The eccentricity of the earth's orbit is 0 016751

ecliptic, *n.* That great circle on the celestial sphere which describes the apparent path of the sun in the course of the year.

The plane of the ecliptic is the plane in which the center of mass of the earth and moon revolves about the sun It is inclined to the plane of the equator at an angle of about 23°27′

ecosphere, *n* A layer in a sphere inhabited by living organisms or suitable for the life of such organisms. **a.** A layer of space about the sun extending from, and including, Venus through Mars **b.** The biosphere of the earth, esp that part of the troposphere extending to about 13,000 feet

effective atmosphere. That part of the atmosphere which effectively influences a particular process or motion, its outer limits varying according to the terms of the process or motion considered. Cf **sensible atmosphere.**

For example, an earth satellite orbiting at 250 miles altitude remains within the ionosphere, but because the air particles are so rare at this altitude as to cause no appreciable friction or deflection, the satellite may be considered to be outside the effective atmosphere For movement of space vehicles the effective atmosphere ends at about 120 miles altitude

ellipse, *n.* A plane curve described about two fixed points (the foci) so that the sum of the distances between any point on the curve and the foci is equal to the sum of the distances between any other point on the curve and the foci.

In the orbit of a planet or satellite, one of the fixed points is the center of the primary body (the sun or the earth) so that the point of greatest nearness in the orbit is 180° from the point of greatest distance through the major axis of the ellipse

engineer, *n.* (engr) A person professionally competent to design, construct, or operate something, esp. as used in such phrases as 'missile engineer,' 'rocket engineer,' or 'scientists and engineers.'

A scientist is one learned in a science or sciences, accustomed and qualified to do theoretical and experimental research in an effort to discover new principles or new knowledge, an engineer is one trained to design or build a structure or machine in accord with principles or knowledge discovered or developed by the scientist

escape velocity. A property of a spatial body expressed in terms of the speed in an outward direction that a molecule, rocket, or other body must move in order for it to escape the gravitational attraction of the spatial body.

The earth's escape velocity is not quite 7 statute miles per second, the moon's about 1 5 statute miles per second

exhaust velocity. The velocity of gases that exhaust through the nozzle of a rocket engine or motor relative to the nozzle. See **thrust,** *n.*

The exhaust velocity may be obtained by multiplying the specific impulse by gravity 32 2 See **specific impulse.**

exosphere, *n.* The outermost fringe or layer of the atmosphere, where collisions between molecular particles are so rare that only the force of gravity will return escaping molecules to the upper atmosphere.

exospheric, *a.* Of or pertaining to the exosphere.

exotic fuel. A fuel considered to be unusual, as liquid hydrogen with a fluorine oxidizer.

exploratory rocket. A rocket built and equipped to explore the upper atmosphere or outer space.

Explorer, *n.* **1.** The first American earth satellite to reach and remain in orbit, launched at 2248 hours (EST), 31 January 1958. Also called 'Alpha' or '1958 Alpha.' **2.** Also applied generically to any other American earth satellite.

The Explorer, with an overall earth weight of 30.8 pounds, consists of an outer skin (that of the last rocket stage) 80 inches long, 6 inches in diameter, which contains a 30-inch long steel shell weighing 7.5 pounds, inside of which is an 11-pound package of complex gauges, meters, wires and miniradio transmitters. The satellite does not tumble as Sputnik II is reported to do, but spins on its longitudinal axis at 700 rpm. It completes its orbit once every 113 or 114 minutes, its apogee 1,600 or more miles from the earth, its perigee 230 miles. It orbits in a plane at 35° to the earth's equator at a velocity of about 18,000 mph.

F

F-108. A projected fighter interceptor expected to develop speeds of mach 3.

Falcon, *n.* An AF air-to-air rocket missile developed by Hughes for use in North American air defense, as with the F-89, F-102, or F-106.

According to press reports, the Falcon's length is 6½', its diameter 1½', its weight 100 lbs, its speed mach 2, and its range 5 miles. It is an aircraft rocket, self-guided by radar (the GAR-1A) or by infrared (the GAR-2A).

fall-away section. Any section of a rocket vehicle that is cast off and falls away from the vehicle during flight.

Farside rocket. A four-stage solid research rocket launched from an unmanned plastic balloon as a part of AF Project Farside.

The rocket, suspended nose upward from the balloon, is fired at an altitude of 20 miles. It tears through the balloon to climb to 4,000 miles.

fps *(abbr).* 'Feet per second.' Cf. **ft/sec** *(abbr).*

free-flight trajectory. That part of a ballistic missile's trajectory that begins with thrust cutoff and ends at re-entry. See **re-entry trajectory.**

free radical. An atom or group of atoms broken away from a stable compound by application of external energy, and, although containing unpaired electrons, remaining free for transitory or longer periods.

Interest centers on three radicals, atomic hydrogen (H), atomic nitrogen (N), and the imine radical (NH). In their free state, they are highly active, combining with each other or with other substances to form other stable molecules, and yielding in the process energies well in excess of those available from conventional chemical fuels. Their use in propulsive systems, now theoretical, depends upon their being isolated and available in bulk, either in pure form or dissolved in a desired concentration in another fuel.

FTCC *(abbr).* 'Flight Test Coordinating Committee.'

This committee is composed of USAF and NACA representatives and a Navy liaison officer to monitor the testing of X-15

ft/sec *(abbr).* 'Feet per second.' Cf. **fps** *(abbr).*

fuel, *n.* Any substance used to produce heat or a rapid expansion of gases esp. by burning; *specif.*, any such substance used to power a rocket motor or rocket engine.

Fuel is distinguished from a propellant (which see) The term is broad enough to include atomic fuels, but in the present state of the art, atomic fuels are considered from 5 to 20 years away for rocket motors.

G

galaxy, *n.* **1.** *Capitalized.* The group of several billion suns, star clusters, nebulae, etc., to which the earth's sun belongs. Also called the Milky Way. **2.** Any of several similar groups of stars forming isolated units in the universe.

The Galaxy (sense 1) is generally considered by astronomers to be shaped like a great disk of stars irregularly dispersed in clusters Its diameter is 30,000 parsecs, its thickness 1,000 to 2,000 parsecs except at the center, where it is 5,000 parsecs or more Outside the central plane other classes of objects are dispersed in spheroidal distribution extending to 5,000 parsecs beyond the central periphery and 10,000 parsecs distant from the galactic plane The spherial diameter of the globular clusters surrounding the center is 30,000 parsecs

The earth's sun is from 8,000 to 10,000 parsecs from the central part of the disk, with a rotational velocity about the central mass of 150 miles per second, taking 200 million years to complete one revolution

GALCIT *(abbr)* 'Guggenheim Aeronautical Laboratory of the California Institute of Technology.'

GAM *(abbr).* 'Guided aircraft missile.'

gantry, *n.* Short for 'gantry crane' or 'gantry scaffold.'

gantry crane. A large crane mounted on a platform that runs back and forth on parallel tracks.

gantry scaffold. A massive scaffolding structure mounted on a bridge or platform supported by a pair of towers or trestles that run back and forth on parallel tracks, used to service a large rocket as the rocket rests on its launching pad.

This structure is a latticed arrangement of girders, tubing, platforms, cranes, elevators, instruments, wiring, floodlights, cables, and ladders—all used to attend the rocket At Cape Canaveral, one of the gantries stands 150 feet high

gapa *(abbr).* 'Ground-to-air pilotless aircraft.'

gasoline, *n.* (gas) A hydrocarbon fuel used as a bipropellant with liquid oxygen. See **specific impulse,** note.

Genie, *n.* An AF air-to-air rocket missile for use in air defense, developed by Douglas.

The Genie uses a solid propellant and carries a nuclear warhead It is also known as the MB-1

geophysical constant. A quantity that expresses a fixed value for a law or magnitude that applies to the physics of the earth.

The constant of gravitation and the constant of nutation are examples of a geophysical constant

gimbaled motor. A rocket motor mounted on a gimbal, i.e., on a contrivance having two mutually perpendicular and intersecting axes

of rotation, so as to obtain pitching and yawing correction moments.

GM *(abbr)* 'Guided missile.'

Goose, *n* An AF air-to-air turbojet missile developed by Fairchild.

According to press reports, the Goose is guided by radio command It is also known as the SM-73

grain, *n*. The body of a solid propellant used in a rocket, fashioned to a particular size and shape so as to burn smoothly without severe surges or detonations

A grain may be very long (40 or 50 inches, for example), shaped to fit the requirements of the rocket, and referred to by its shape, as in *tubular grain, cruciform grain, triform grain*, etc

gravireceptor, *n*. *Medicine*. A nerve ending that responds to the mechanical stimulation of gravity.

gravisphere, *n*. The spherical extent in which the force of a given celestial body's gravity is predominant.

Green Room. *Specif*. A room of the Cape Canaveral Central Control that serves as the command center.

guidance system. One of the systems in a ballistic missile that puts the missile on a desired trajectory at a desired velocity prior to thrust cutoff, or a system in a guided missile that establishes the desired path from launch to target. See **control system,** note.

guided aircraft missile. (GAM) A guided missile launched, or designed for launching, from an aircraft.

guided missile. (GM) **1.** A missile directed to its target while in flight or motion, either by a preset or self-reacting device within the missile or by radio command outside the missile. **2.** *Restrictive*. Such a missile without wings to support it

This term is sometimes considered synonymous with 'pilotless aircraft' when the missile is supported by wings The two terms, however, suggest two different points of view, although applied to the same object The guided missile is a missile, the pilotless aircraft is a vehicle

H

hardware, *n*. Finished pieces of equipment or component parts that constitute or go to make up an operating machine or device such as a missile or vehicle.

In a missile, the hardware covers the airframe, the metalic or ceramic parts of the motor, and the instruments It does not include the fuel The term is often used to differentiate equipment and parts in their physical state from their status on the drawing board

Hawk, *n*. An Army ground-to-air missile developed by Raytheon.

This missile is said to be 16 feet long, 200 pounds in weight, with a speed of mach 2 plus, and a range of 15 miles plus Powered by a solid rocket, it is guided by radio command

heat of vaporization. The heat absorbed by a liquid when it vaporizes; the quantity of heat required at a given temperature to convert a unit mass of liquid into vapor.

heliocentric, *a.* Measured from the center of the sun; related to, or having, the sun as a center.

Hidyne, *n.* Also spelled **Hydyne.** A popular name for the hydrazone propellant of the Jupiter-C first-stage rocket.

This term is a coinage, *Hi* plus *dyne.*
Hidyne is reported to have boosted the standard Redstone burning time and burnout velocity by 12 percent.

Honest John. An Army ground-to-ground solid rocket artillery projectile developed by Douglas.

This missile is reported to be 27 feet long, 2½ feet in diameter, weighing 3 tons, with a range of 30 miles. It is guided by the amount of its thrust and by the direction of its launch.

human engineering. The art or science of designing, building, or equipping an aircraft or space vehicle to the anthropometric, physiological, or psychological requirements of a person.

hydrazine, *n.* A liquid base, NH_2NH_2, or one of the organic bases derived from it, as phenylhydrazine. Used as a liquid propellant.

hydrazone, *n.* An exotic fuel used in the first stage of Jupiter-C, formed by the action of hydrazine or one of its derivatives on a compound containing the carbonyl group, CO.

hypersonic, *a.* Of or pertaining to the speed of an object moving at mach 5 or greater relative to surrounding fluid.

hypoxia, *n. Medicine.* Oxygen deficiency in the blood, cells, or tissues of the body in such degree as to cause psychological and physiological disturbances.

Hypoxia may result from a scarcity of oxygen in the air being breathed, or from an inability of the body tissues to absorb oxygen under conditions of low barometric pressure In the latter case, water vapors from body fluids increase in the sacs of the lungs, crowding out the oxygen.

I

ICBM *(abbr).* 'Intercontinental ballistic missile.'

IGY *(abbr).* 'International Geophysical Year.'

IGY satellite. One or other of the artificial earth satellites developed for purposes of the International Geophysical Year (which see).

One of these satellites is a 20-inch sphere, with a thin magnesium skin coated with a highly polished silicon monoxide, designed to measure the Lyman-Alpha radiation in the outer ultraviolet band of sunlight, and to transmit its measurements by means of a miniature transmitter. Another is a 13-inch sphere designed to carry an inflatable subsatellite.

IM *(abbr).* 'Interceptor missile.'

inclination, *n.* The angle between one line and another or one plane and another, as the angle between the plane of the moon's orbit and the ecliptic.

inertial force. The force produced by the reaction of a body to an accelerating force, equal in magnitude and opposite in direction to the accelerating force.

Inertial force endures only so long as the accelerating force endures

inertial guidance. A kind of guidance for a missile

or the like, effected by means of mechanisms that automatically adjust the missile after launching to follow a given flight path, the mechanisms measuring inertial forces during periods of acceleration, integrating the data obtained with already-known position and velocity, then signaling the controls to effect the desired direction, altitude, etc.

inhibitor, *n.* Anything that inhibits; *specif.,* a substance bonded, taped, or dip-dried onto a solid propellant to restrict the burning surface and to give direction to the burning process.

intergalactic space. That part of space conceived as having its lower limit at the upper limit of interstellar space, and extending to the limits of space. See **galaxy,** *n.,* **space,** *n.*

Like the term *interstellar space,* this term is defined from an earthbound standpoint.

intermediate range ballistic missile. (IRBM) A ballistic missile with a range above 200 miles but less than 1,500 miles.

The limitations of range as shown are subject to change as new concepts of weapons employment are entertained.

International Geophysical Year. (IGY) See note.

The IGY, beginning 1 Jul 1957 and ending 31 Dec 1958, is a period scheduled by the world's scientists for a concerted and cooperative effort to advance scientific knowledge of the world, esp. in respect to cosmic rays, meteorology, latitude and longitude determinations, solar activity, geomagnatism, glaciology, oceanography, seismology, ionospheric physics, aurora, and gravity measurements Some 55 nations support the program, the US Congress appropriating $39 million, and the National Academy of Sciences undertaking to plan, direct, and execute the US program Prior to the IGY, preliminary work had been done by different scientific groups to provide facilities and bases from which to carry out the program.

interplanetary space. That part of space conceived, from the standpoint of the earth, to have its lower limit at the upper limit of translunar space, and extending to beyond the limits of the solar system, some several billion miles.

This term is one of distance from the earth, not one of planetary influence.

interstellar space. That part of space conceived as having its lower limit at the upper limit of interplanterary space, and extending to the lower limits of intergalactic space.

This term, as defined, is from the standpoint of an observer on the earth From the standpoint of a detached observer, it is that part of space within the Galaxy (which see).

IOC *(abbr).* 'Initial operational capability.'

ion, *n.* An electrically charged atom or group of atoms. See next.

A positively charged ion is an atom or group of atoms with a deficiency of electrons; a negatively charged ion is an atom or group of atoms with an added electron.

ion engine. A projected species of reaction engine in which thrust is to be obtained from a stream of ionized atomic particles supplied by atomic fission, atomic fusion, or solar energy. Cf **photon engine.**

This engine, designed for interplanetary travel in space where air particles offer no resistance to motion, is projected to have relatively low thrust but sufficient to build up to speeds of 100,000 mph.

ionize, *v. tr.* To make an *atom* or *molecule* of a gaseous element, such as a *particle* of air, lose an electron, as by X ray bombardment, and thus be converted into a positive ion, the freed electron then attaching itself to another molecule to form a negative ion.

ionosphere, *n.* An outer stratum of the atmosphere consisting of layers of ionized air particles.

As conceived by some meteorologists, the ionosphere begins at approximately 25 miles above the earth, by others at approximately 50 miles It varies in height with the season of the year and the time of day By some, it is considered to extend to the outermost fringe of the atmosphere beyond 1,000 miles, by others, it is considered to be bounded at its upper limits by the exosphere, or by a sphere called the mesosphere. It reflects certain radio waves and reaches temperatures of several thousand degrees It is divided into layers, the *D layer, E layer, F layer,* each defined in the *USAF Dictionary.*

IRBM *(abbr).* 'Intermediate range ballistic missile.'

isothermal region. The stratosphere considered as a region of uniform temperature. See **atmosphere,** *n*, note.

J – K

Jet Propulsion Laboratory. (JPL) A laboratory in the Guggenheim Aeronautical Laboratory of the California Institute of Technology.

JPL, organized in 1936, conducted research and development on jet propulsion for the armed services. Its first leader was Dr. Theodor von Karmán.

JPL *(abbr).* 'Jet Propulsion Laboratory.'

Jupiter, *n.* An Army ground-to-ground IRBM, with a first-stage liquid-rocket engine, developed by Chrysler.

This missile, as distinguished from the research rocket Jupiter-C, is 60 feet long, 8 feet in its maximum diameter, and has a range of 1,500 miles, a speed in excess of mach 1. Its original first-stage rocket was that of the Redstone missile. It has an inertial guidance system. See next.

Jupiter-C, *n.* The four-stage Army carrier rocket that first successfully launched an American manmade satellite, Explorer, into orbit at 2248 hours (EST), 31 January 1958.

The Jupiter-C, 70 feet long, is a research version of the IRBM Jupiter In the launching of Explorer, the first stage consisted of a liquid rocket using a hydrazone exotic fuel, two other stages used clusters of solid propellants, the fourth stage consisted of a single rocket motor

Kelvin scale. (° K) [After the first Baron *Kelvin* (1824–1907), English mathematical physicist and inventor.] A temperature scale that uses centigrade degrees, but makes the zero degree signify absolute zero.

Water freezes at 273.16° K, boils at 373 16° K. Cf. **Rankine scale.**

Kepler's laws. The three laws of planterary motion discovered by Kepler (1571–1630) that explain the movements of planets in terms of the Copernican concept.

These laws are 1 The orbit of every planet about the sun is an ellipse, the sun occupying one focus 2 A line from each planet to the sun sweeps over equal areas in equal times 3 The squares of the times required for the different planets to complete their orbits are proportional to the cubes of their mean distances from the sun.

kill, *n.* **1.** An act or instance of destroying an enemy aircraft or missile in midair. **2.** The thing destroyed.

L

Lacrosse, *n.* An Army solid rocket ground-to-ground missile, produced by Martin.

This missile is reported as 20 feet long, 9 feet in span, and a range of 20 miles It is guided by radio command by a forward observer

Laika, *n.* The name of the female dog carried as a passenger in Sputnik II.

Laika, of the Husky breed, approximately 45 pounds in weight, about 20 inches high, survived alive in the satellite from the 3rd to the 10th or 11th of November 1957. The Russians announced her alive on the 10th, dead on the 11th.

launch, *n* The procedures or action taken in launching a rocket missile or vehicle; the resultant event of this action See **vertical launch**

A launch begins when the missile or vehicle moves upward off the launcher upon ignition of the propellant, and normally ends when the missile or vehicle has achieved a velocity at which it responds to normal control through the guidance system

launch, *v. tr.* To send forth under its own power a *rocket vehicle, robot bomb,* or the like from a launching pad, rack, ramp, or other device or installation; also to rocket a *satellite* or *test sphere* upward.

launching pad. Same as 'launch pad.'

launch pad. 1. The base on which a positioned rocket missile or vehicle rests ready for launching. Usually called the 'pad.' **2.** Also applied to the site for a launch.

In sense 1, the launch pad for an uprighted missile or vehicle is usually of steel and concrete Sense 2, reported as common, is somewhat inexact usage

launch point. The point at which a ballistic missile or other rocket vehicle is launched.

light, *n.* A radiant energy that stimulates the organs of sight to perform their function, consisting, according to modern theory, of quanta transmitted at about 186,000 miles a second; by extension, a related radiant energy, such as infrared, that does not affect the retina, but otherwise acts like the same energy.

light year. The distance over which light can travel in the period of one year's time—some 6,000,000,000,000 miles, i.e., 6,000 billion miles.

liquid oxygen. Oxygen supercooled and kept under pressure so that its physical state is liquid. Used as an oxidizer in a liquid-fuel rocket.

Liquid oxygen, supercooled to as low as −297° F and kept under a constant pressure for use in a rocket, is highly explosive and requires special handling It boils at −297° F at atmospheric pressure, has a specific gravity of 1 14, and a heat of vaporization of 91 6 BTU per pound It is noncorrosive and nontoxic, but cannot be stored for any great length of time because of rapid evaporation It is usually produced close to the place where used Cf **alcohol,** *n.*, **specific impulse.**

liquid propellant. 1. A rocket propellant that consists either of a mixture of two or more liquids (a fuel, oxidizer, and sometimes an additive) or of a liquid chemical compound that provides its

own fuel and oxidizer 2. Also any one of the liquid ingredients that are to go into the mixture, i.e., the fuel, the oxidizer, or the additive, separately.

liquid rocket. 1. A rocket that uses liquid fuel **2.** Short for 'liquid rocket propellant.'

Little John. An Army ground-to-ground solid rocket artillery projectile developed by Douglas.

This missile, reported to be 12 feet long, 1 foot in diameter, with a range of 15 miles, is a short version of Honest John, developed esp for airlift

long-range, *a* or *attrib* (LR) Of a missile: Having a range greater than 1,500 miles. Used esp. in phrase *long-range ballistic missile*

The limitations of this definition are subject to change as new concepts of weapons employment are entertained Cf **intermediate range ballistic missile**

LOX *(abbr)* 'Liquid oxygen explosive.'

This abbreviation is not used for 'liquid oxygen' It is, essentially a commercial term applied to an explosive made up of liquid oxygen

lunar space. Space near the moon. Cf. **terrestrial space, translunar space.**

The gravitational attraction of the moon is predominant n lunar space

M

mach, *n.* [After Ernst *Mach* (1838-1916), Austrian physicist] A unit of speed measurement for a moving object equal to the speed of sound in the medium in which the object moves

Thus, *mach 5* is a speed equal to one-half the speed of sound in the medium, *mach 1* is a speed equal to that of sound in the medium Cf **remote velocity, speed of sound.** At transonic speeds, a body may have a speed less than mach 1 at the same time that local points on the body have speeds greater than mach 1

Mach speed has no meaning in an element that does not conduct sound See **atmosphere,** *n*, note

manned vehicle. *Specif.* An air or space vehicle that carries a person or crew. Distinguished from a pilotless aircraft, an unmanned earth satellite, a ballistic missile, or the like.

mass, *n* A measure of the quantity of matter in a body, being determined by comparing the resultant changes in velocities when the body impinges upon a standard body.

The unit for determining mass in the US is a piece of platinum kept in Washington, D C, by the National Bureau of Standards Mass differs from weight in that the weight of this piece of platinum is the attraction of the earth's force of gravity upon it In Washington, the mass and weight have equivalent values, at other points the mass remains the same, the weight, however, varies with latitude and elevation

mass ratio. The ratio of one mass to another; *specif.*, the ratio between the initial mass of a full vehicle (takeoff mass) and the final mass of the vehicle or payload (remaining mass)

For example, in the V-2 the mass of the rocket was 3 tons, the payload 1 ton, the fuel 8 tons Takeoff mass was 12 tons, remaining mass is 3+1 or 4 tons The mass ratio is 3 to 1

Matador, *n* An AF winged guided missile, surface-to-surface, developed by Martin Also called the TM-61.

The Matador, 40 feet long, 29 feet in span, with a weight of 7 tons, s propelled by a short-lived turbojet

engine (the Allison J33-A-37) with an assist from a rato unit An air-breather, it has a speed of 650 mph, a range of 500 miles or more, and a radar guidance system Now considered obsolete

Matador Mace. An AF ground-to-ground winged guided missile, similar to the Matador, developed by Martin Also called the TM-76A.

This missile, provided with an inertial guidance system and more range than the Matador, is propelled by a turbojet engine with a rato assist

mechanical border. *Specif.* That layer in the atmosphere where air resistance and friction become negligible (from 120 to 140 miles altitude). See **effective atmosphere.**

mechanoreceptor, *n. Medicine.* A nerve ending that reacts to mechanical stimuli, as touch, tension, and acceleration.

mesosphere, *n.* **1.** In the nomenclature of Chapman, a stratum of atmosphere sometimes called the chemosphere. **2.** In the nomenclature of Wares, a stratum that extends approximately from 250 to 600 miles, lying between the ionosphere and the exosphere.

In sense 2, the mesosphere s the region of sunlight auroras

meteor, *n.* A transient celestial body, natural in origin, that enters the earth's atmosphere with great velocity; also recently applied to such a body encountered or existent outside the atmosphere.

A meteor, incandescent with heat generated by friction with the air, can be mistaken for a ballistic missile.

meteoric particle. A particle of matter from a meteor; a small meteor.

mini *(prefix).* A contraction of 'miniature' used in combination, as in *minicomponent, miniradio, minitransistor;* also a contraction of the words thus made, as in *minitrack,* i.e., a minitransmitter track. See following entries.

miniature, *n.* Used attrib. in reference to equipment, such as gimbals, gyroscopes, computers, etc., made small to fit into confined spaces, as within an earth satellite or rocket missile.

miniaturize, *v. tr.* To make a functioning miniature of a *part* or *instrument.* Said of telemetering instruments or parts used in an earth satellite or missile, where room is at a premium.

Hence, **miniaturized,** *a.*, **miniaturization,** *n.*

minitrack, *n* **1.** The track of a minature transmitting set emitting telemeter-type signals. **2.** Short for 'minitrack radio.' Used attrib., as in *minitrack chain, minitrack picket.*

minitrack radio. A radio receiving set that tracks an object equipped with a miniature transmitter emitting telemeter-type signals. Used, for example, in tracking earth satellites.

missile, *n.* **1.** Any weapon object designed to be thrown at, dropped upon, projected toward, or self-propelled through space to, a target. **2.** *Specif.* A guided or ballistic missile. Often attrib., as in *missile base, missile force, missile*

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guidance, missile research, missile warhead. **3.** Short for 'missile vehicle.'

missileman, *n* A person who works on or handles a missile; *specif.*, an airman or officer in a missile unit.

missile range. A marked-off course or area over which test missiles are flown under observation. Also called 'missile test range.'

The missile range for Cape Canaveral extends out into the Caribbean and South Atlantic some 5,000 miles

missile unit. A military unit made up of persons with the skills required to service, make ready, or launch guided or ballistic missiles, or to train others to do so.

missilry, *n.* The art or science of designing, de-developing, building, launching, directing, and sometimes guiding a rocket missile; any phase or aspect of this art or science.

monopropellant, *n.* A rocket propellant, esp. a liquid propellant, in which the fuel and oxidizer make up a single substance before injection into the combustion chamber.

A monopropellant may be a mixture of compounds, such as hydrogen peroxide and alcohol, or a compound in itself, such as nitromethane The term is normally applied to liquid monopropellants rather than to solid propellants, to distinguish them from the liquid bipropellants

moon, *n.* **1.** The natural celestial body that orbits as a satellite about the earth. Called 'the moon.' **2.** Also applied generically to any one of the manmade earth satellites, or to a satellite of a planet other than the earth.

In sense 1, the moon has a diameter of 2,160 miles, a mean distance from the earth of about 238,857 miles, a mass about 1/81st that of the earth, and a volume of about 1/49th Its mean orbital velocity is about 2,285 statute mph, its apogee 252,710 miles, its perigee 221,463 miles

moon rocket. A rocket vehicle used to carry a payload to the moon, either to circle it and return to earth, or to land upon it.

multistage rocket. A rocket having two or more thrust-producing units, each used for a different stage of the rocket's flight.

N

NACA *(abbr).* 'National Advisory Committee for Aeronautics'

Created by act of Congress 3 Mar 1915. NACA has 17 members, 2 of them from the AF Its 3 principal laboratories are the Langley Aeronautical Laboratory at Langley AFB, the Ames Aeronautical Laboratory at Moffett Field, and the Lewis Flight Propulsion Laboratory at Cleveland

Navaho, *n.* A long-range air-breathing guided missile developed by North American. Also called the SM-64.

This intercontinental missile is propelled by two ramjet engines, except that it is normally rocket-boosted to an altitude of 50,000 or more feet

Neptune, *n.* An early name for the Viking when it was in the development stage.

Nike, *n.* [Pronounced *Nigh-kee*] Any of three different ground-to-air missiles developed, or being

developed, by Douglas and Western Electric for the Army

The *Nike-Ajax*, a liquid rocket missile with a solid booster, 20 feet long, 5 feet in span, weighing 1,000 pounds, with a speed of mach 2, a range of 30 miles is guided by radio command The *Nike-Hercules*, a solid rocket missile with a cluster of boosters, is said to be 27 feet long, 2 feet in diameter, with a weight of 2,000 pounds, a speed of mach 3, a range of 70 miles It is guided by radar or radio command The *Nike-Zeus*, under development, will probably have a range of 100 miles

node, *n.* Either of the two points where the orbit of an orbiting body intersects the plane of the orbit of its primary. Cf. **ecliptic,** *n*

NorAD *(abbr).* 'North American air defense.'

North American air defense. (NorAD) A coordinated defense of the North American continent against air or missile attack. Cf **air,** *n*, note

The defense is coordinated as between American and Canadian services with full use of early-warning radar

nose cone. A cone-shaped shield that fits over, or is, the nose of a rocket vehicle or rocket missile, built to withstand high temperatures generated by friction with air particles.

The nose cone, having shielded a satellite as it travels through the atmosphere, may be separated from the satellite in outer space by an explosive cartridge In a missile, the warhead, together with auxiliary equipment, such as a fuzing system, is put into the nose cone

nutation, *n. Astronomy* A free but balancing motion of the earth's axis, in which its inclination to the plane of the ecliptic varies by a few seconds of arc, and the celestial poles describe wavy parallels about the poles of the ecliptic; any slight inequality in the motion of precession.

The constant of nutation for the earth is 9 21″ ***Lunar nutation*** is a perturbation due to action of the moon, ***solar nutation*** due to change in the sun's declination

O

orb, *n.* A spherical body, esp. a celestial sphere, as the moon, a planet, or a manmade satellite of that shape.

orbit, *n* The path described by a body in its revolution about another body, as by a planet about the sun or by a manmade satellite about the earth Sometimes used without an article, as in *to put in orbit, to be in orbit* (said of an earth satellite).

The orbit normally is an ellipse, thus, a line connecting the center of the orbiting body with the center of the primary body sweeps over equal acreas in equal times This means that the orbiting body moves fastest when nearest its primary body

orbit, *v intr.* Of a celestial body or manmade satellite: To revolve about another body.

orbital bomber. A projected bombing aircraft with the capability of near-orbiting or orbiting speeds to allow the craft to circle the earth once or more times at very high altitudes and then glide back to base.

Rocket propelled, an unmanned version could do reconnaissance, a manned version bombing

orbital glider. A vehicle that achieves sufficient velocity to attain an altitude so as to revolve

about the earth a desired number of times before falling (or gliding) back to earth.

orbital rocket. A rocket with sufficient range and speed to achieve an orbit about the earth.

orbital velocity. **1.** The average velocity at which an earth satellite or other orbiting body orbits. Cf. **separation velocity.** **2.** The velocity of such a body at any given interval in its orbit, as in 'its orbital velocity at the apogee is less than that of the perigee.'

When the orbital velocity is given at 17,000 mph. for example, this is considered to be in sense 1

ORDiR *(abbr).* 'Omnirange digital radar.'

outer space. **1.** In contexts of currently developing practical aero-space activities, the space above the earth's atmosphere, or above its effective atmosphere. **2.** Space beyond the limits of the solar system, as in 'an intruding meteor from outer space.'

In sense 1, the first sputnik is said to have orbited in outer space, but its orbit at 370 to 560 miles was well within the outer reaches of the earth's atmosphere It was reported as falling when its perigee declined and reached 120 to 130 miles

oxidizer, *n* A substance that combines with another to produce heat and, in the case of a rocket, a gas.

The oxidizer normally contains oxygen, or is itself oxygen, but it may be another substance, such as fluorine as used in an exotic fuel Chemically, an oxidizer increases the proportion of the electronegative part in a substance.

ozonosphere. A stratum in the upper stratosphere at an altitude of approximately 40 miles having a relatively high concentration of ozone and important for its absorption of ultraviolet radiation from the sun.

P – Q

pad, *n.* Short for 'launch pad.'

parallax, *n.* The apparent displacement of an object, or the apparent difference in its direction of motion, if viewed from two different points.

The parallax of the moon and sun may be observed in the difference between their angular altitudes above the bubble horizons and their angular altitudes above the celestial horizon.

parsec, *n.* A unit of measure for interstallar space equal to 3.26 light years.

The parsec has a heliocentric parallax of one second of arc

payload, *n. Specif.* In a rocket vehicle, that which is carried to obtain the results for which the vehicle is launched.

In a guided missile, the payload is the warhead intended to damage or influence the enemy, in a sounding rocket (which see) the payload comprises the instruments animal, or mechanisms sent aloft to obtain data; in a satellite rocket carrier, the payload is the satellite.

perigee, *n.* That point in an earth satellite's orbit at which it approaches nearest the earth. Cf. **apogee,** *n.,* sense 1.

perihelion, *n.* That point on a planet's or comet's orbit nearest the sun. Cf. **aphelion,** *n.*

The earth's perihelion is about 91,500,000 miles from the sun

period, *n.* The interval of time required for a periodic motion to complete a cycle.

perturbation, *n.* A disturbance in the regular motion of a celestial body, the result of a force additional to that which causes the regular motion.

For example, the center of mass of the solar system approximates the center of the sun, but it moves with regard to it in response to attractive forces of the planets This movement introduces perturbations.

Petrel, *n.* A Navy air-to-underwater turbojet missile developed by Fairchild.

The Petrel, by press reports, weighs 3,800 pounds, has a length of 24 feet, a span of 13 feet, a range of 50 miles, and homes by radar as an underwater torpedo

photon engine. A projected species of reaction engine in which thrust is to be obtained from a stream of light rays.

Although the thrust of this engine is considered to be minute, it can be indefinitely applied to build up speeds approaching the speed of light—186,000 mps.

photosynthesis, *n. Medicine.* A process found in green plants in which carbohydrates are formed under the influence of light with chlorophyl serving as a catalyst.

planetology, *n.* The study of planets and satellites, esp. in regard to the interpretation of their surface markings.

Polaris, *n.* A Navy solid-rocket IRBM designed to be launched from a surface ship or submarine, developed by Lockheed.

The Polaris may be launched subsurface.

postsputnik, *a.* Of or pertaining to time after the launching of the first manmade satellite, Sputnik I, 4 October 1957.

propellant, *n. Specif.* **1.** The mixture of fuel and oxidizer and sometimes an added chemical or chemicals, used in a rocket motor or rocket engine. **2.** Also applied singly to any one of the ingredients of a liquid propellant, i.e., to the fuel, the oxidizer, or to an additive. See **bipropellant,** *n.*, **liquid propellant, monopropellant,** *n.*, **solid propellant. 3.** Also applied to a fission reactor or fusion reactor.

Proxima Centauri. One of the two nearest known stars to the earth, about 4.3 light years distant.

The other nearest star, *Alpha Centauri*, is in the same constellation.

Quail, *n.* An AF air-to-surface cruise missile decoy undergoing development by McDonnell. Also called GAM-72.

R

radial velocity. The velocity of approach or recession between two bodies, esp. between an observer and a source of radiation, in a line connecting the two.

The magnitude and direction of radial velocity is determined by Doppler effect (which see).

radio command. A radio signal to which a guided missile, drone, or the like responds.

Ramo-Wooldridge Corporation. A private corpo-

ration, located in Inglewood, California, which carries out the overall systems engineering for the USAF in accordance with its responsibilities as technical advisor to the Air Force Ballistic Missile Division of Headquarters ARDC.

Systems engineering for the USAF is a function of the Space Technology Laboratories, The Ramo-Wooldridge Corporation

Rankine scale. [After W. J. M. *Rankine* (1820–1872), Scottish physicist.] (° R) A temperature scale that uses Fahrenheit degrees, but makes the zero degree signify absolute zero.

In the scale, water freezes at 491 69 degrees, and boils at 671 69 degrees Cf **Kelvin scale.**

Rascal, *n.* An AF guided aircraft missile (air-to-surface) developed by Bell esp for use by SAC aircraft. Also called GAM-63.

rato, *n.* ['Rocket assisted takeoff.'] **1.** A takeoff assist by a booster rocket unit normally using dry fuel. **2.** The power unit used in such a takeoff.

reaction engine. An engine or motor that derives thrust by expelling a stream of moving particles to the rear.

This engine works in accordance with the third law of motion, i e, every action produces an equal and opposite reaction. Jet engines, rocket engines, ion engines, photon engines are species of the reaction engine. Another reaction engine is reported in development—one that will utilize free radicals (which see) as fuel

reaction motor. A reaction engine, esp. one that is comparatively uncomplicated in design or operation.

reaction time. *Specif.* The interval of time between a command to launch and the actual launch.

Considered to be an attribute of a weapon or weapon system, as in 'the ballistic missile has a reaction time unmatched by a manned bomber.'

receptor, *n.* *Medicine.* A sensory nerve ending for perception of physical and chemical conditions of environmental agents and forces acting upon the body.

reconnaissance satellite. An earth satellite designed to obtain strategic information, as through photography, television, etc.

Redstone, *n.* An Army surface-to-surface liquid research rocket developed by Army Ballistic Missile Agency and produced by Chrysler.

The Redstone is reported to be 69 feet long, 6 feet in diameter, capable of mach speed, and with a range of 350 miles Its guidance is inertial. Its rocket motor is used on the Jupiter IRBM.

re-entry, *n.* The event occurring when a ballistic missile or other object comes back into the sensible atmosphere after being rocketed to altitudes above the sensible atmosphere; the action involved in this event. Attrib., as in *re-entry problem.*

re-entry trajectory. That part of a ballistic missile's trajectory that begins at re-entry and ends at target. See **free-flight trajectory.**

Regulus, *n.* Either of two Navy surface-to-surface turbojet winged missiles, developed by Chance Vought.

Regulus I is reported to be 33 feet long, 21 feet in span, 4½ feet in diameter, weighing 6 tons, with a speed of 738 mph and a range above 500 miles, guided by command radio or by homing *Regulus II* is 57 feet long, 20 feet in span, 7 feet in diameter, with mach 2 speed, and a range above 1,000 miles. Both need a booster rocket to get them airborne.

reliability research. The theoretical and applied research involved in developing test equipment to test test equipment, as in missile building.

remaining mass. The mass of that part of a rocket missile, rocket vehicle, or its payload that remains after the fuel or fuels have been exhausted, and after fall-away sections or parts have been cast off See **mass ratio.**

In the case of Jupiter-C and its satellite, the remaining mass was that of the last rocket stage, the steel shell within it, and the package of instruments within the shell

remote velocity. The velocity of an object taken as a whole relative to the surrounding fluid, as distinguished from the local velocity of any of its parts.

research rocket. A rocket vehicle used to determine the validity or reliability of data and equipment being developed.

right ascension. The arc of the celestial equator, or the angle at the celestial pole, measured eastward from the hour circle of the vernal equinox to the hour circle of a given celestial body, either through 24 hours or 360 degrees.

robo, *n.* A rocket orbital bomber. *Obs.*

robot bomb. An explosive-carrying winged missile or rocket, like the German V-1, normally launched from the surface and directed in powered flight towards its target by an automatic pilot and other automatic devices.

rocket, *n.* **1.** A rocket vehicle or a rocket missile. **2.** A rocket motor or a rocket engine, i.e., a motor or engine that moves itself forward by ejecting a stream of hot gases to the rear and is independent of the atmosphere for its operation.

The rocket (sense 2) is a species of reaction engine, but differs from a jet engine in that the latter is dependent for oxidation upon air taken in from the atmosphere whereas the rocket can operate in outer space, either by carrying its own oxidizer or by relying upon some other system to produce a jet stream, as with a nuclear reactor working upon a fluid

rocket, *v.* **1.** *tr.* To send an *object*, as an earth satellite or test sphere, into the sky by means of a carrier rocket. **2.** *intr.* Of a missile or vehicle: To move upward or forward in reaction to a rocket.

rocket engine. **1.** A rocket propulsive device that is relatively complicated in its workings, as distinguished from a rocket motor; hence, the liquid-fuel rocket device: See note and see **rocket,** *n.*, sense 2. **2.** In less exact usage, a rocket motor or, generically, any rocket propulsive device.

The liquid-fuel engine with its elaborate pumping equipment, pressure chambers, fuel lines, electrical connections, etc., is more appropriately called an engine, as in sense 1, than the solid-fuel motor. The term 'rocket motor'

is preferred over 'rocket-engine' as the generic term. See **rocket motor.**

rocket missile. A missile (which see) that uses rocket propulsion. See **rocket** *n.*, sense 2.

rocket motor. 1. In exact usage, a rocket propulsive device that burns a solid self-oxidizing fuel, as distinguished from a rocket engine. **2.** Generically, either the liquid-propellant rocket or solid-propellant rocket, or theoretically, the fission reaction or fusion reaction engine that emits a jet stream.

In sense 1. the device consists essentially of a combustion chamber that houses the grain plus a nozzle and igniter Cf **rocket engine.**

rocket propellant. A propellant used in a rocket.

rocket vehicle. A vehicle propelled by a rocket motor or rocket engine.

ruggedize, *v.* To make a *piece* of equipment rugged enough for practical use. *Popular.*

S

SAM *(abbr).* 'Surface-to-air missile.'

satellite, *n.* **1.** *Specif.* An attendant body that revolves about another body. See **center of mass. 2.** A manmade object designed, or expected, to be launched as a satellite. See **IGY satellite.**

scientist, *n.* A person learned in a science or sciences, accustomed and qualified to do theoretical and experimental research as he seeks out new principles or new knowledge. Cf. **engineer,** *n.*

second of arc. *Astronomy.* A measure of an angle, 1/60th of a minute.

selenocentric, *a.* Relating to the center of the moon; referring to the moon as a center.

sensible atmosphere. That part of the atmosphere that may be felt, i.e., that offers resistance. See **effective atmosphere.**

separation velocity. The velocity at which a space missile or space vehicle is moving when some part or section is separated from it; *specif.*, the velocity of an earth satellite at the time of separation from the carrier.

Sergeant, *n* An Army surface-to-surface solid rocket missile, developed by Sperry.

The Sergeant is reported to be 25 feet long, 3 feet in diameter, weighing 15 tons, with mach speed, and range of 75 miles Its guidance system is thought to be inertial

Shrike, *n.* A surface-to-air liquid-rocket guided missile being developed by Bell.

sidereal time. Time measured by reference to the apparent motion of the first point of Aries.

A sidereal day begins and ends when the first point of Aries is directly over the reference meridian Due to the motion of the earth around the sun, a sidereal day is almost 4 minutes shorter than the solar day

Sidewinder, *n.* A Navy air-to-air rocket missile developed for air defense by Philco and General Electric.

According to press reports, the Sidewinder is powered by a solid propellant, is 9 feet in length, weighs 155 pounds, and achieves a speed in excess of mach 2. It is guided by infrared

single-stage rocket. A rocket vehicle or missile provided with a single rocket propulsion system.

slenderness ratio. A configuration factor expressing the ratio of a rocket vehicle's length to its diameter.

sloshing, *n.* The back-and-forth splashing of a liquid fuel in its tank, creating problems of stability and control in the vehicle.

SM *(abbr).* 'Strategic missile.'

Snark, *n.* An AF surface-to-surface winged intercontinental air-breathing missile, developed by Northrop. Also called the SM-62.

The Snark, 69 feet long, 42 feet in span, 15 feet in diameter, weight 18 tons, has a speed somewhat less than mach 1 and a range of 5,000 miles It is powered by an axial-flow turbojet engine (the Pratt & Whitney J57), with rato

solid propellant. A rocket propellant consisting of of a single solid substance, usually a powder made into a grain of a particular size and shape. See **grain,** *n.* Cf. **specific impulse.**

A solid propellant consists of all the ingredients necessary for sustained chemical combustion It may be a heterogenous mixture of an oxilizing agent and a fuel, for example, crystals of perchlorate with asphalt, or it may be a chemical compound that provides its own oxidizer, as with nitrocellulose mixed with other chemicals to control rate and direction of burning

A solid propellant is also a monopropellant, but the latter term is seldom used to refer to it See **monopropellant,** *n*, note

solid rocket. 1. A rocket that uses a solid propellant. **2.** Short for 'solid rocket propellant.'

solid rocket fuel. A solid propellant.

sonic speed. The speed of an object at mach 1 relative to the surrounding fluid.

sophisticated, *a.* Of a weapon system: Complex and intricate; requiring special skills to operate. Accepted *slang.*

sounding rocket. A research rocket used to obtain data on the upper atmosphere.

The Wac Corporal and Aerobee were, or are, sounding rockets The Aerobee, exemplifying the equipment carried, has a radio antenna, telemetering equipment, telemetering channels, batteries, an animal container, a beacon, and a parachute This payload weighs 150 pounds. Recovered after flight, the sounding rocket gives up data additional to that obtained during flight.

space, *n.* **1.** That which extends in all directions, and has no outward bounds nor limits of divisibility, as in 'the sun and its planets move in space.' **2.** *Restrictive.* A part of this extension marked off or bounded in some way, as by the outer limits of the earth's atmosphere; *specif.,* the extent between the earth's atmosphere, or effective atmosphere, and an outer indefinite boundary, in which extent earth satellites may be put in orbit, ballistic missiles made to follow a plotted trajectory, or vehicles (manned or unmanned) moved about relative to spatial bodies.

In the specific sense of sense 2, this term is used as an attrib to designate various actions, things, or concepts associated with space as defined

Space is often conceived as void, but also as a receptacle in which matter is present in the form of meteors, meteoric dust, and radiation particles. Different extents of space have been usefully conceived as in the terms ***cislunar space, intergalactic space, interplanetary space, interstellar***

space, lunar space, and *terrestrial space*. See separate entries.

In sense 1, space, as conceived by non-Euclideans, is boundless but not infinite in extent; its conception is inseparable from the conception of time.

space biology. A branch of biology concerned with life as it may come to exist in space.

Space biology is a discipline used in the practice of space medicine.

space cabin. A pressurized and climatized cabin for use in space flight.

space laboratory. 1. A space vehicle carrying sensing and measuring instruments, recording equipment, radio-transmitting equipment, and other related instruments, used as a means of obtaining scientific data on conditions in the upper regions of the earth's atmosphere or in outer space. **2.** A vehicle that simulates the conditions of a space vehicle.

The space laboratory (sense 1) may be manned or unmanned

space law. A projected code of international law that would govern the use or control of space by different nations.

Andrew G. Haley and Theodor von Kármán have suggested that the line between the jurisdictions of air law and space law be drawn at the altitude where continuous flight by aircraft ceases to be possible, about 55 miles above the earth.

space medicine. An extension of aviation medicine concerned with the study, prevention, cure, or alleviation of illnesses or diseases expected to arise, or arising, from space flight.

space rocket. A rocket missile or rocket vehicle designed to reach the space above the earth's atmosphere, or, in some contexts, above the earth's effective atmosphere. See **atmosphere,** *n.*

space vehicle. A contrivance that carries something into or through space, either returning to the earth or not.

A space vehicle may be manned or unmanned, but is considered to be under man's control in at least a part of its flight The term is broad enough to include objects otherwise called guided or ballistic missiles if they are being considered as carriers of something through space

space warfare. Warfare conducted by use of weapons brought to bear upon earth targets from outer space, or brought to bear upon targets in outer space.

space weapon. A weapon that travels through space and is directed against an enemy target whether on the ground, in the air, or in space.

Sparrow, *n.* One or other of three Navy air-to-air rocket missiles: See note.

The *Sparrow I*, developed by Sperry, reportedly weighs 300 pounds, has a speed of 1,500 mph and a range of 8 miles, the *Sparrow II* is undergoing development by Douglas (December 1957), and the *Sparrow III*, developed by Raytheon, reportedly weighs 350 pounds, with a speed in excess of 1,500 mph

spatial body. Any body or aggregate of matter that exists in space and behaves in accordance with astronomic or astrophysical law.

This term includes the earth as well as celestial bodies. Cf. **celestial body.**

specific impulse. A performance parameter of a rocket propellant, equivalent to the effective

exhaust velocity divided by gravity, expressed in pounds per second. See **thrust,** *n.*

Some typical sea-level specific impulses for different propellants are listed not for absolute correctness, but as a comparative guide Liquid oxygen and ammonia, 255–265, liquid oxygen and ethyl alcohol, 243, liquid oxygen and gasoline, 242, liquid oxygen and hydrazine, 259, liquid oxygen and liquid hydrogen, 317–364, hydrogen peroxide and hydrazine, 252, nitromethane, 218; potasium perchlorate ($KClO_4$) and C_2H_4O, 165–210, potasium perchlorate and asphalt, 180–185, nitrocellulose, nitroglycerin, and additives, 205–230

specific thrust. Specific impulse.

speed of sound. The speed at which sound waves travel through a medium. See note and **mach,** *n.*

Sound travels at different speeds through different mediums, and at different speeds under different conditions of temperature, pressure, etc In air under standard sea-level conditions, sound travels at about 1,100 ft/sec or 750 mph.

sphere of gravitational influence. Gravisphere.

sputnik, *n.* Often *capitalized.* [Russian *s* 'with' *put* 'path' and *nik* 'agent,' i.e., 'that on a path with.] A satellite, esp. a manmade moon launched by the Russians, the first on 4 October 1957, the second on 3 November 1957. Cf. **Laika,** *n.*

The first sputnik, with a weight of 184 pounds, a diameter of 22 8 inches, and an orbital velocity of 18,000 mph, was put into an elliptical orbit ranging in height from 370 to 560 miles, and in a plane at 65° to that of the earth's equator The second sputnik, carrying a dog, was put into orbit at a maximum height above 900 miles, with an earth weight of 1,118 pounds, and a velocity of 26,250 fps or 17,897 mph. The estimated weight of the first rocket vehicle was 220,000 pounds, that of the second, 385,000 pounds

The full Russian designation is *Iskustvenyi Sputnik Zewli* 'artificial companion of the earth' The first satellite is often called 'Sputnik I,' the second 'Sputnik II.'

SSM *(abbr).* 'Surface-to-surface missile.'

stage, *n.* **1.** The interval of time in the flight of a rocket vehicle or rocket missile resulting primarily from the thrust of a single rocket motor, rocket motor cluster, or rocket engine. Used attrib. in combination, as in *three-stage rocket,* i.e., a rocket vehicle or missile designed to use three successive propulsive systems during powered flight. **2.** Also applied to any one of the rocket units that operate in such an arrangement, or to a section of the vehicle that contains such a unit, as in 'charges to break apart the three rocket stages.'

static firing. The firing of a rocket motor or rocket engine in a hold-down position to measure thrust and accomplish other tests.

static testing. The testing of a device in a stationary or held-down position as a means of testing and measuring its dynamic reactions. Said esp. of a rocket motor as a means of measuring thrust.

step rocket. A rocket with two or more stages.

strategic attack. *Specif.* An attack by means of long-range guided or ballistic missiles (together with long-range bombers or aircraft serving as launch platforms for air-to-surface missiles) directed at selected vital targets of an enemy nation so as to destroy his war-making capacity or his will to fight.

strategic missile. (SM) A guided or ballistic missile usually with a range in excess of 1,500 miles, designed for use in strategic attack (which see). The Atlas, Goose, Snark, Thor, and Titan are SM's. See separate entries.

stratosphere, *n.* **1.** A stratum of the atmosphere lying immediately above the troposphere and, as treated by some meterologists, immediately below the chemosphere. **2.** Also applied to a thicker stratum extending through the chemosphere.

As conceived in sense 1, the stratosphere, extending from above 7 miles to 19 miles, and characterized by horizontal and predominantly westerly air movements with a more or less constant temperature, is also called the isothermal region In sense 2, the stratosphere extends to about 50 miles.

subsatellite, *n.* An object designed to be carried into orbit inside an artificial earth satellite but later ejected to serve a particular purpose.

For example, an inflatable subsatellite has been designed to measure air density and satellite drag.

supersonic, *a.* Of or pertaining to the speed of an object moving at a speed greater than mach 1 relative to surrounding fluid. Cf. **hypersonic,** *a.*, **speed of sound.**

Technically, *supersonic* is generic and includes the concept of *hypersonic*, but some writers use it restrictively for relative speeds between mach 1 and mach 5 Use of *ultrasonic* as a synonym of *supersonic* is discouraged, it is a term of acoustics

systems engineering. *Specif.* The process of applying science and technology to the study and planning of an overall missile system, whereby the relationships of the various parts of the system and the utilization of various subsystems are fully planned and comprehended prior to the time that hardware designs are committed.

Use of the plural 'systems' refers to the many separate systems that must be combined in order to build an overall missile system. See **ballistic missile, note.**

T

takeoff weight. The weight of a rocket ready for takeoff.

This weight includes the weight of the vehicle, the fuel, and the payload.

Talos, *n.* A Navy ground-to-air missile developed by Bendix. Also called IM-70.

The Talos is 20 feet long, weighs 1½ tons, has a speed of mach 3 and a range of 25 miles Powered by a ramjet motor, it is guided by riding a radio beam.

tape recorder. An instrument that records on magnetic tape variations in electrical quantities such as current, potential, power, and frequency, the quantities then being subject to a playback with interpretations in sound, graphic display, or the like. Used in the telemetering equipment of man-made satellites or missiles, or in the recording of signals from a radio transmitter.

Tartar, *n.* A Navy ground-to-air rocket missile being developed by Convair.

telemeter, *n.* An electronic instrument that senses and measures a quantity, as that of speed, tem-

perature, pressure, or radiation, then transmits radio signals to a distant station, where, indicated or recorded, they are interpreted by code into the quantity provided for. Cf. **tape recorder.**

Telemeters are important instruments in earth satellites or test spheres, also in ballistic and guided missiles.

telemetry, *n.* The practical art of using telemeters. Attrib., as in *telemetry device.*

temperature, *n.* (temp) The relative hotness or coldness of a thing measured on a definite scale, esp. as a factor in employing space weapons or carrying out space operations, as in the re-entry problem of ballistic missiles.

The theoretical lower limit of temperature is absolute zero (approximately −273 16° C or −459 69° F), no upper limit is considered to exist See **Kelvin scale, Rankine scale.**

terrestrial space. Space comparatively near the earth in which the attraction of the earth is predominant.

Terrier, *n.* Either of two Navy ground-to-air missiles developed by Convair.

Terrier I, 15 feet in length, uses a solid rocket and attains a speed of mach 2 plus *Terrier II* is said to be guided by radar.

test equipment. Equipment used in testing the capabilities and characteristics of experimental operational equipment. See **reliability research.**

test failure. A failure to achieve a sought-after result by virtue of a miscalculation, inadequate equipment, or the like, during the research and development phase of a rocket missile or vehicle.

test sphere. *Specif.* A sphere designed to be rocket-carried to the expected orbital height of a satellite for purposes of testing equipment, esp. minitrack transmitters, prior to the launching of the satellite.

test vehicle. A vehicle, such as a rocket vehicle, used to test experimental equipment being developed for operational use.

thermosphere, *n.* The ionosphere considered as a region of temperature variation from −28° F to several thousand degrees.

Thor, *n.* An AF surface-to-surface liquid-rocket strategic missile, developed by Douglas. Also called the SM-75.

The Thor, in research and development, is an **IRBM.** Several test firings have been successful. It is considered an adequate vehicle for launching a satellite if adapted to the purpose

thrust, *n.* The force that drives a rocket missile or vehicle in a direction normally parallel to the longitudinal axis of the rocket, measured in terms of the fluid mass flow of its propellant in pounds per second multiplied by the effective exhaust velocity (relative to the airframe) in feet per second divided by gravity acceleration (at the equator 32.2 feet per second per second).

thrust cutoff. The stoppage of the reaction process in a rocket. Attrib., as in *thrust-cutoff point.*

Titan, *n.* An AF surface-to-surface strategic mis-

sile, developed by Martin. Also called SM-68.

The Titan, in research and development, is reported as having a range of 5,000 miles with an inertial and radar guidance system.

transistor, *n.* An electronic device that controls an electron current by the conducting properties of germanium or like material.

The transistor is similar to the vacuum tube in uses, but is itself a nonvacuum device.

translunar space. That part of space conceived as a spherical layer centered on the earth, with its lower limits at the distance of the orbit of the moon, but extending to several hundred thousands of miles beyond. Cf. **lunar space.**

This term is one of distance from the earth, not one of the moon's influence

Tritan, *n* A Navy surface-to-surface ramjet missile, developed by McDonnell.

The Tritan is 47 feet long, weighs 10 tons, develops mach 3 speed, and has a range of 1,500 miles It has inertial guidance and is submarine-launched

troposphere, *n.* The lower layer of the earth's atmosphere, extending to about 60,000 feet at the equator and 30,000 feet at the poles.

The thickness varies with the seasons and with different meteorological conditions

Tsiolkovsky, K.E. A Russian engineer and scientist (5 Sep 1857–1935) whose paper "Rockets into Cosmic Space" (1903) was one of the pioneer works in the achievement of rocket flight.

tumble, *v. intr.* Of an oblong earth satellite: To rotate about its horizontal axis, end-over-end. Said of Sputnik II.

U – V

umbilical cord. Any one of the servicing electrical or fluid lines between the ground and an uprighted rocket missile or vehicle before the launch. *Figurative.*

universe, *n.* The entire spatial cosmos.

unobtainium, *n.* A substance having the exact high test properties required for a piece of hardware or other item of use, but not obtainable either because it theoretically cannot exist or because technology is insufficiently advanced to produce it. *Humorous* or *ironical.*

upper air. *Geophysics.* That part of the atmosphere that embraces the ionosphere and the exosphere.

V-1. [Abbr. of German *Vergeltungswaffe eins* Revenge Weapon One.] A German robot bomb (which see) used in WW II. Also called the FZG-76 by the Germans, and the buzz bomb by the British.

The V-1, first launched across the English Channel on 13 June 1944, was powered by a pulsejet engine mounted on its back It had a speed of about 360 mph, a range of 150 miles, and flew at 2,000 to 3,000 feet altitude Some 2,000 of these weapons were directed against England in WW II

V-2. [Abbr of German *Vergeltungswaffe zwei.*]

A German liquid rocket, developed as a ballistic missile in WW II.

The V-2, first launched against England on 8 Sep 1944, developed 60,000 pounds of thrust. Without wings, it was subject to some guidance through movable panels built into the four tail fins and through graphite vanes extending into the exhaust stream Launched vertically, it reached a speed of 3,600 mph, then tilted in the direction of its target, reaching an altitude of about 60 miles with a range of 200 miles, and then plunging earthward without power at about 1,500 mph Some 1,115 V-2's were sent across the channel in the last six months of WW II After the war, the V-2 became a research rocket in both the US and Soviet Russia One of its test flights in the US is said to have reached a height of 120 miles.

Vanguard, *n.* **1.** A project of the US Naval Research Laboratory concerned with developing a carrier rocket and satellites, the latter to be placed in orbit during the International Geophysical Year. Officially called 'Project Vanguard.' **2.** Short for 'Vanguard carrier rocket' or 'Vanguard satellite.'

Vanguard carrier rocket. A three-stage carrier rocket developed under Project Vanguard for placing a satellite in orbit.

This carrier rocket, 72 feet in length and 22,600 pounds in weight, is a modification of the Viking with a slenderness ratio of about 19 to 1 Its first two stages use liquid propellants, its third a solid propellant Its horizontal velocity increment totals 25,817 ft/sec or 17,603 mph

Vanguard satellite. A satellite designed for, or adapted to, the Vanguard carrier rocket for launching. See **IGY satellite.**

vanishing-man concept. A concept of warfare that visualizes more and more use of robots, machines, and automation with a corresponding use of fewer and fewer men.

This concept is not to be considered necessarily valid.

velocity, *n.* **1.** A vector quantity that includes both magnitude (speed) and direction relative to a given frame of reference. **2.** Commonly used as a synonym of speed.

vernal equinox. The point where the sun appears to cross the celestial equator from south to north. Also called 'the first point of Aries.'

vernier engine. [Named after Pierre *Vernier* (1580–1637), French mathematician.] A rocket engine of small thrust used to obtain a fine adjustment in the velocity and trajectory of a ballistic missile just after the thrust of the final stage main engines has been cut off.

vertical launch. A launch in which the missile or vehicle starts from a vertical position.

Viking, *n.* A liquid research rocket built by Martin and Reaction Motors for the Navy, first launched 3 May 1949.

The Viking, a single-stage liquid rocket, in length from 42 to 48 feet, in diameter 32 inches, weight between 9,650 and 15,000 pounds, developed a thrust of 20,000 pounds for 75 seconds Modified, the Viking is the first stage of the Vanguard carrier rocket.

This rocket was called 'Neptune' in its early development It was also nicknamed 'Marco Polo' by persons who worked on its manufacture.

W – X – Y – Z

Wac Corporal. A sounding rocket for very high

altitudes, developed by the Jet Propulsion Laboratory during the late 1930's and 1940's.

The Wac Corporal was 16 feet long, 1 foot in diameter, weighed 665 pounds with fuel (280 pounds dry weight) and payload, and was propelled by liquid fuel. Adapted for use as a second stage of the V-2, it reached an altitude of 250 miles on 25 Feb 1949 at White Sands Proving Ground, New Mexico.

warhead, *n.* That part of a missile that constitutes the explosive, chemical, or other charge intended to damage the enemy.

weapon system. (WS) A total complex (embracing design concepts, production, hardware, logistical support, training measures, maintenance and operating manpower) that goes into the development, production, and employment of a weapon.

A given ballistic missile, for example, is more than a missile At first, it is considered the best possible design for its purpose—in terms of the length of time for its development and production, the number of men to handle it, the amount of training in specific AF specialties, its workability under combat conditions Then settled upon as a practicable design, each of its subsystems (guidance, propulsion, etc) must be developed under coordinated control called 'systems engineering.' Created as a piece of hardware, it must be tested, maintained, and supported As it reaches production, ground crews must be brought to a peak of training to handle it Thus conceived, the ballistic missile is a weapon system; it contributes to doctrine and sets war plans

weightlessness, *n.* A property or attribute of being without weight.

If a body has overcome the gravitational attraction of the earth (or other spatial body), as by velocity, it is without weight, since weight is defined as the product of the body's mass times the acceleration of the body due to gravity.

Wizard, *n.* An AF ground-to-air missile system in research and development by Convair and RCA.

WS *(abbr).* 'Weapon system.'

WS-110. A projected manned bomber expected to develop speeds of mach 3 and the capability of staying aloft for several days flying at above 75,000 feet.

WS-117L. A reconnaissance satellite being developed by Lockheed.

WS-131B. An AF air-to-surface missile undergoing development by North American.

WS-132. An AF air-to-ground missile undergoing development by North American for launch from a B-52.

X-15. A rocket research aircraft in research and development, with the National Advisory Committee for Aeronautics (NACA) the technical director acting for the USAF and the Navy.

Begun in December 1954, the X-15 is scheduled to fly in 1959 North American Aviation and Reaction Motors are the contractors With a length of 50 feet, a diameter at the tail of 4 feet, short blunt wings of 22 feet span, a gross weight of 16 to 16½ tons, an inertial guidance system, the X-15 is expected to range as high as 300 miles at speeds of mach 5 to mach 7 in terms of lower atmospheric flight. The X-15 is to be manned.

X-17. A rocket test vehicle being developed by Lockheed.

zerogravity, *n.* A condition existent when the centripetal gravitational attraction of the earth or other spatial body is nullified by inertial (centrifugal) forces.

Ziolkowski. Variant of TSIOLKOVSKY.

Mr. FELDMAN. Are there techniques for penetrating cloud cover from a reconnaissance satellite?

General BOUSHEY. Yes, sir; I believe there are. I am sure you are acquainted with radar which works through cloud cover, and infrared will work as long as the cloud cover is not too deep.

In other words, infrared detection is possible through a certain measure of water vapor. Water vapor seems to attenuate it more than other gases.

Mr. FELDMAN. Were you not for a brief time a director of astronautics in the Air Force?

General BOUSHEY. I think it was a day and a half, sir.

Mr. FELDMAN. What happened to your projected office?

General BOUSHEY. It was disestablished, sir.

Mr. FELDMAN. Has ARPA taken over all the functions you would have had?

General BOUSHEY. No, sir. We still do them.

Would you like me to explain that, sir?

Mr. FELDMAN. Yes.

General BOUSHEY. I was the Deputy Director of Research and Development. The Air Force felt after the Sputniks I and II were launched, that it would be worthwhile to have a small office in the air staff to give full time and attention to space matters. I was selected. It was to be a very small office not to exceed 10 people, about 5 military and 5 civilian, and this would help Secretary Douglas, General White, and others on the staff, on space matters.

This office was disestablished because I understood ARPA was then in the process of formation and they wanted to find out how ARPA would work with the services before a service established any particular staff office of its own labeled "Astronautics."

Colonel Dillon and I have been the only two working on this for months, on the same job under a different name.

Mr. FELDMAN. One last question. We have heard a lot about the cost of these various ventures and explorations. What about the payoff in terms of weather control and communications, and so on?

General BOUSHEY. Sir, I agree that the payoff would be probably so valuable that we cannot even appreciate it at this time.

Again I hate to refer to this TV movie of the Russian film, but they even pointed out the possibility of very valuable minerals on the moon. This might catch the imagination, but I think there will be other things that are more valuable than minerals. It might be new knowledge and new things that we discover.

Mr. FELDMAN. In the form of weather control or weather prediction itself, you might be able to control floods and things of that sort. Is that not so?

General BOUSHEY. If you could not control them, we could at least give warning, sir.

Mr. McDONOUGH. Yesterday we had a witness, Dr. Simon Ramo, and he said that the benefit from weather predictions by satellites in orbit for that purpose alone would be more valuable to the military than it would be to civilian uses. If we knew, in launching or shooting an ICBM, what the weather conditions were at the point of target more accurately than we do now, then we would be more accurate in our firing.

Now, you are a military man. What do you think of that?

General BOUSHEY. I think he is probably correct, sir.

Mr. McDONOUGH. What do you think of the possibility of transportation, worldwide transportation, by a satellite in orbit?

General BOUSHEY. I do not think that is an efficient use of a satellite.

Mr. McDONOUGH. I say a satellite—a controlled satellite, a controlled space vehicle.

General BOUSHEY. You are referring to something like ICBM for transporting supplies or humans?

Mr. McDONOUGH. Yes.

General BOUSHEY. I think it would be a very expensive way to do it. While I won't discount there might be a need, I don't see it.

Mr. McDONOUGH. In communications, for instance, would that be a great benefit to the military at the present time?

General BOUSHEY. And civilians as well, sir; very great.

Mr. McDONOUGH. So that the major things that we might obtain as a byproduct for civil uses from the experiments on the military side are weather prediction, communications, and transportation, for whatever it may be worth?

We could at least find out whether it was profitable. Are there any other things in satellite return that we might anticipate?

General BOUSHEY. Yes, sir, I believe the Navy has proposed that they could put a satellite in orbit and use it as a most useful means of navigation; that is, navigation at sea.

They could detect this satellite by both radar and optically, perhaps at midday. I would be what they call a stationary object and stay at one place over the equator and rotate at the same angular rotation that the earth does.

It would then be just a matter of measuring the angle to know where you were as regards latitude and longitude.

Mr. McDONOUGH. It would be like the stars?

General BOUSHEY. Better than that. It could be quite accurate, I have been told.

The CHAIRMAN. Gentlemen, you will have an opportunity to edit your testimony.

We hope you will enlarge where you think it will be helpful and clarify your remarks.

In other words, you can add new thoughts in the editing of your testimony.

For myself and members of the committee, I express our appreciation to you for your appearance and for your testimony.

General BOUSHEY. Thank you, sir. I consider it a privilege to be here.

The CHAIRMAN. The Chair understands outside the committee room are 50 Girl Scouts from Mrs. Rogers' district. This is a good time to suspend for the moment.

(A short recess was taken.)

The CHAIRMAN. The committee is very glad to have you young ladies here. You see a committee in operation. This is the hearing room of the committee which your distinguished Representative, Mrs. Rogers, is a very prominent member of, and was chairman of when the Republicans were in control. I might say she is one of the ablest Representatives we have in Congress. I have a very high regard for

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Mrs. Rogers as a legislator and as a great American. We are glad to welcome you here.

Now, the next witness will be Dr. Raemer Schreiber, leader of N Division, Los Alamos Scientific Laboratory, of the Atomic Energy Commission.

Doctor, we will be very glad to hear from you.

STATEMENT OF DR. RAEMER SCHREIBER,[16] LEADER OF N DIVISION, LOS ALAMOS SCIENTIFIC LABORATORY, ATOMIC ENERGY COMMISSION

Dr. SCHREIBER Mr. Chairman, I have assumed that what you would like to hear is a story of the nuclear rocket propulsion program or the Rover program. While I do not have a completely written out statement, I have a prepared statement which I can present and then be available for questions after that, if it is agreeable with you.

The CHAIRMAN. You may proceed any way you wish, Doctor.

Mr. SCHREIBER. Thank you.

The Rover program, which is the nickname for the nuclear rocket propulsion development, is being supported by the Atomic Energy Commission and by the Air Force. It is administered by Maj. Gen. Donald J. Keirn, who wears two hats essentially. He is the head of the Aircraft Reactors Branch of the Division of Reactor Development for the Atomic Energy Commission, and he is also a Deputy Assistant Chief of Staff for Development in the Air Force headquarters. His deputy is Col. J. L. Armstrong.

This work under the AEC which I am directly concerned with is assigned to the Los Alamos Scientific Laboratory and I am head of the division which has been given the major responsibility for this program.

I would like to say that I am not directly cognizant of the Air Force support of this work, although I naturally keep up to date on it reasonably well. This is handled primarily by contract from the Wright Air Development Center to the Rocketdyne division of North American Aviation and the Aerojet General Corp.

What I would like to do, since you have had many expert witnesses talking about the missions which might be accomplished, is to concentrate on the technical program and tell you something of the reasons why we are interested in this, why we think the Nation is interested, and something of the way we are going about it. In order to do that, I will have to remind you again of some rocket fundamentals and I will try not to be too painful about this, but I do have a point I would like to make.

If you are dealing with long-range rockets, you are dealing with very enormous amounts of energy. You must have this source of energy, you must be able to expend it usefully in a very short period of time, and you must do it in a fashion which gives you the maximum thrust to your rocket for the amount of material which is carried simply because a rocket, when it starts its operation, must carry

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[16] Schreiber, Dr R(aemer) E(dgar), Los Alamos Scientific Lab, Box 1663, Los Alamos, N Mex Physics. McMinnville, Oregon, Nov 11, 10; m; c 2. B A Linfield Col, 31; M A, Oregon, 32, Oregon State Col, 32–35, fellow, Purdue, 37–38, Ph D. (physics), 41. Grad asst physics, Oregon State Col, 32–35, Purdue, 35–57, instr., 37–42; research assoc., Office Sci Research & Develop and Manhattan Dist proj., research foundation, Purdue, 42–43 Mem Staff, Neutron Physics and Eng, Los Alamos Sci Lab, 43— Fel. Physical Soc Neutron physics, chain reactor; physics, nuclear engineering.

everything with it which it uses. The amount of energy involved is really quite large.

A large missile, for example, requires for a short period of time something like 3 million kilowatts of power. This is like taking the entire amount of electricity needed for a city the size of Chicago, and putting it through an engine about the size of an office desk. You don't do it for long, but you must do it over a period which is, maybe, a few minutes.

Now, in chemical systems, the source of energy, of course, is the propellant, which is an oxidizer and a fuel which is either mixed in the chamber in the case of the liquid system or is in some safe chemical combination in the solid propellant system and, upon being heated ignites and burns and you get the thrust by ejecting the exhaust gases, the combustion products, at high velocity through a nozzle.

In order to get a measure of the effectiveness of this thrust, there are some terms which undoubtedly are in these glossaries which one must define. But, basically, the measure of the effectiveness of this thrust is what is known as specific impulse, which is the pounds thrust per pounds per second of the propellant which is ejected. This also is proportional directly to the exhaust velocity. The higher the exhaust velocity, the more thrust one gets per pound of propellant which is ejected.

Now, this enters into the calculation of the size, the weight of a rocket, in a fashion which I will not go into, but it is relatively simple. It results in what is known as the vehicle mass ratio, which is the ratio that the vehicle has to start with divided by the mass which it has when it has exhausted its fuel. This, then, is determined by a very powerful function involving the ratio between the velocity you achieve and the velocity of exhaust of the propellant.

Rather than to try to give a lot of illustrations of this, let me take a specific example.

Suppose that you ask for a velocity of 16,000 feet per second. This is about what is needed for a 1,500-mile terrestrial mission, ground to ground. Suppose also you have a chemical system which has an exhaust velocity of 8,000 feet per second, or specific impulse of 250. This is common to existing chemical motors. Then you do the calculations and find that you must have 7 pounds propellant burned for every pound you put into this velocity of 16,000 feet per second. This is not too bad. This means that you have 15 percent of your gross takeoff weight left for the engine, controls, structure, the tankage, and the payload.

Suppose they ask that you go up to about 30,000 feet per second, which is about what is required for a low-level satellite if you make some allowance for atmospheric drag and work done in working against gravity getting to altitude. Then this number of 7 pounds goes up to 40 pounds. So now you have left only 2½ percent of your gross takeoff weight for the structure, the engine, et cetera, and the payload. This turns out to mean that you don't get to the payload because you don't have enough weight allowance. Obviously what you do in this case then is to stage. You ask that, say, it all go up to only half of the final velocity and then you put on as part of the payload of the first stage the second stage, which does not weigh as much, and this is the course which is actually followed.

In principle, one can get some fraction of this takeoff weight into an orbit. It is probably unfair to regard Explorer and Vanguard as representative of the best chemical missiles because they have been done on a short time scale and with available equipment, but it is interesting to note that they only get 1 pound of useful payload out of between 1,000 and 2,000 pounds of takeoff weight in these particular cases.

You can go on up in performance demands, and suppose you want to do a soft landing on the moon or a one-way mission to Mars (and I could get into an argument with the other people on what it really requires), but let us assume it requires 60,000 feet per second. Then it calls for 1,800 pounds of propellant burned for each pound you get there, and this is the theoretical upper limit. You can't beat this. The laws of physics tell you you cannot do better than this. But something less than this probably can be done by making many stages.

However, you have again a question of reliability. If you have many stages, all of which must work, for example, if you have four stages and they are each 90 percent reliable, then the probability of actually completing the mission is only 66 percent. So the use of many stages has certain drawbacks quite aside from the fact that it is quite difficult to get a large amount of weight delivered.

If I wanted to really push this to the extreme and talked about 75,000 feet per second, which maybe gets you back from Mars or something of this sort, now you are at a limit of 11,000 pounds of propellant for each pound that you deliver, and you cannot beat that with a specific impulse of 250.

Now, all I am trying to do here is to say that if you are really interested in these ambitious missions, you really want a higher specific impulse. Then you ask, How is the best way of going about this?

With chemical systems, it is possible in principle to go up to something like 400 pounds thrust per pound per second or, to use the abbreviated form, 400 seconds. This is an increase of from 250 to 400, and this pays off very considerably. This permits one, for example, to get about 1 percent, theoretically, of your takeoff mass up to 60,000 feet per second. So you can talk then about 1 percent split up into many stages, and this again you cannot beat by any scheme.

On the other hand, if you can increase this specific impulse by rather a substantial amount, and I am taking a factor of 3 over the original example, say 750 seconds, then it is just as easy to do a 60,000-foot-per-second mission as it is to do a 20,000-foot-per-second mission, with 250 seconds, and you come back to 3 or 4 pounds as the required propellant weight. Clearly, if this could be done very cheaply and quickly, we would do it at once. It is not so quick and cheap, but we feel that the method of nuclear propulsion offers a very good probability of accomplishing this.

So the question is then, What can nuclear propulsion do which chemical systems cannot? You can go back then and you say, in the first place, you must have a source of energy and this is clearly no problem, because the amount of energy stored in nuclear form is about 10 million times that of chemical.

Then you ask, How can I convert this into a useful form?

Mr. McDonough. Is that an arbitrary figure you are speaking about when you speak of 10 million times?

Mr. Schreiber. You take the energy in a pound of uranium 235 and compare it with an average sort of energy in a chemical explosive or chemical propellant and it comes out in this order of magnitude. I

will not guarantee whether this is 1 or 6 times that, but it is so large that actually there is no problem at all in having this energy available in a very compact and lightweight form.

Then you ask, How can one really make use of this?

The obvious solution, the classical illustration which you probably have had presented here already, is to essentially combine the features of chemical rockets and of nuclear reactors. And instead of burning the propellant to get the energy, you heat it up by passing it past a solid fuel reactor. This is the "Old Pokey" concept which I think Dr. Merkle talked about a week or so ago.

Then you ask, well, this is fine, but what have you accomplished, because you have obviously substituted a new system here, you have introduced possibly some new problems, and can it really accomplish very much?

Here again I must go back to the basic ideas of how the specific impulse depends upon the characteristics of the propellant, and basically, the two factors are the temperature of the propellant and its average molecular weight.

We are now going to talk about this wedding of the reactor and rocket engine. In chemical systems, you are already pushing the limits of material melting point so we cannot do much with the temperature. However, you can do something about molecular weight.

In the chemical system, the molecular weight is determined by the fact that you have combustion products, such as water vapor and carbon dioxide, and these have molecular weights of 18 or higher.

In nuclear systems you have a single propellant which you can adjust, and obviously the lowest molecular weight is hydrogen with a molecular weight of two. Since the dependence is the square root of this ratio, you come up with a factor of three in specific impulse in operating a nuclear hydrogen system at the same temperature as the chemical system.

So this in principle, you see, gives us a factor of 3, which I talked about in saying you can do a 60,000-foot mission with the same difficulty as you can a 20,000-foot mission in terms of this particular parameter.

Now it is quite a long story as to whether you can do this, what weight of system you need, what the complications are, but here at least is a first approach which could be looked at and, let us say, does not depend too much on imagination. It is somewhat within the state of the art and is specifically, I think, an engineering development.

Now, if you say this is still not good enough, you want to do better, there are of course ideas all over the country, there are ideas on going not to solid fuel as such but fluid fuel. You deal with a liquid uranium compound or a gaseous compound, and then are not restricted in temperature.

Furthermore, if you go up into the very high temperatures, one starts getting into the disassociation and ionization phenomena which constitute new ways of taking the heat out of the fission process and putting them into the propellant.

Now, I present this as a rather lengthy introduction in order to say two things: that a higher specific impulse, a higher level of performance, is certainly of interest if we are talking of space exploration, and, second, that there are ways of using nuclear energy in which this can be done.

That is essentially the basis on which the Rover program has been started. It has been going for 3 years. Rather, I should say it started 3 years ago and it took quite a bit of time to get up momentum.

Our guidance from the AEC was an instruction to explore the feasibility of the nuclear rocket systems, and it was left to the laboratory to determine the best way of doing this. In view of the fact that this was an early exploratory effort, it was very desirable to have this freedom, but we did have to make up our mind which way we were going to approach the problem.

There are obviously two extremes. One is that you can grab on the thing which seems to be most available, concentrate all effort on this, and press for a quick result. This is rather risky. If you fail, you have failed in a fashion which will make it difficult to pick up the pieces and go on. The results probably would not be as good as though one had settled down to the other extreme, which would be to start basic research in materials, radiation effects, reactor operations, and so on and on, but this could go on also, however, for a good many years and might not give you a practical result.

The guidance that we had and the things that we listened to were fairly conflicting. There were some people who would say we must have this done in a hurry, so that if there is a serious defect in the chemical propulsion system, we need nuclear propulsion for defense purposes, we must have something ready to go.

There were other people who felt this could be a program which could be pursued in a fairly leisurely fashion. It was an interesting byproduct of the missile and atomic age, and sometime in the near future we might be interested in using this. Since we could not get any coherent opinion, we had to make up our own minds and undertook a combination of some specific design work and some basic research work. The specific design work which was undertaken is resulting now in the test reactor which I think has already been announced will be put in the test stand at Nevada near the end of this year. We are still continuing this dual approach, and we think that it has a considerable merit. By having specific problems to point to, the basic supporting work is given some direction and it does not wander around over a wide field without discriminating between the trivial and the important problems.

On the other hand, having supporting research which is not rigorously tied to the specific development problem, we occasionally have the happy surprise of having a solution readymade when we run into the practical problem or of having a suggestion of a way of avoiding the problem altogether.

Now, the talents which are required for this sort of work cover a fair variety of fields. It is clear that, no matter what specific system is used, one is always interested in pushing to the maximum temperatures possible. This means that work must be done on the study of the properties of high-melting-point materials, and these are obvious to anyone who goes through a handbook. There are things like graphite or carbon, tungsten, molybdenum, tantalum, the carbides of these metals, and others, oxides and so on.

Very little work has been done in the extreme high-temperature field. It has been discouraging to find that when we got a lead on somebody that had been doing high-temperature research that he thought that 1,500° F. was real hot. This means that there is a lot of basic work that must go on.

Clearly, a reactor is not going to operate unless there is some fissionable fuel in it, so one must study the behavior of uranium and plutonium compounds to see how they stand up under various conditions. So there is a great deal of basic-materials work required. Then, if you are going to get serious about a specific design, you have to ask what are the properties of these real materials, how do they behave under thermal stresses, under mechanical loads?

And then finally, since your reactor is not going to just sit there and glow quietly, but must be exchanging heat to some propellant which is roaring through it at a great rate, there must be studies of the interactions between the proposed propellants and the fuel materials.

We have, for example, at Los Alamos, a bank of four submarines' worth of storage batteries. These are all hooked up with massive bus bars and switches so that we can short-circuit the output of this through a test specimen in order to give some simulation of the power densities which are required in these rather high-power-density reactors.

In terms of the reactor studies themselves, the problem is not too different from the development of a power reactor, although the requirements are here more stringent in some ways.

One thing in our favor is that we are not expecting these to run for years, but only for minutes. Therefore, tests can be conducted relatively quickly.

On the other hand, these reactors must be brought up to power in periods measured in seconds rather than in hours or days, as in the case of power reactors, and they must respond to command signals within fractions of a second if they are to operate successfully. So this calls for a combination of rather extensive calculation and experiments to see how reasonably good mockups of these reactors will work. In fact, at Los Alamos we have a rather extensive remote facility for making these assemblies and actually operating these reactors at low power. This is, of course, due to the bomb physics work which has been going on there. This permits us to go through, in a reasonably short period of time, either an exploration of a new concept or the much more detailed study of a more specific mockup. We actually will check out the real reactors there again at extremely low power before they are put on the test stand. The control of such a reactor must operate in a very short period of time. There is not a time for an operator to sit there and read meters and scratch his head and decide what to do next. The command signals must be given in a short period of time. So there must be an elaborate combination of high-speed digital computer and real time and analog computer work in studying the dynamics of the system. Actually, the control system for the operating reactor has to have in it several digital computers which take the power, the flow level, similar signals, compare those with the desired conditions, and then transmit correction commands to the reactor; and all this must be done in fractions of a second.

I have mentioned the rather elaborate calculations that are required. This obviously calls for machines and technicians, but it clearly takes much more than this. Machines give you back nonsense if you put nonsense into them. So this program calls for a rather strong theoretical support where the problems can be analyzed in

terms of the physical laws and then reduced into terms which can be solved either by hand or by means of a machine.

There is, finally, the problem of integral testing. You first must design and build the test device out of real materials, not hypothetical materials that someone has used on a conceptual study; and then you must decide on the information which is to be obtained and instrument this is an appropriate fashion; and then finally this has to be actually put through an operation.

As you know, there has been an area at the AEC Nevada test site developed for the Rover work. For those of you who are familiar with the area, it is about 12 miles almost due west of the base camp at Mercury. It is in a region known as Jackass Flats. We hope this does not have any adverse connotation. Anyway, we have in almost the final stages of construction a test area there which has three major installations located approximately on an equilateral triangle, on the points of such a triangle.

There is first the control building, from which the reactor's test devices are operated and which have all of the data-recording equipment and a small administrative area associated with this.

On another point of the triangle is a maintenance assembly and disassembly building, which of course became abbreviated to the MAD building and in this the reactor is assembled in an ordinary, fairly large room with a crane, and it is disassembled after its operation in a large shielded hot cell, which is somewhat similar to the installations at ARCO, the reactor testing ground up there. The reactor is assembled, I should say, on a test car which runs on a standard railroad track and is then hauled out to the third installation, which is the test cell area proper, where it is plugged into the test cell and finally connections are made and the system is checked out. Then this area is cleared and the operations conducted from the control room. After the test is over, the reactor on its test car then is brought in by a remotely operated locomotive which brings it in and shoves it into the hot cell of the MAD building where it is then disassembled for final inspection and post mortem.

The samples which are of particular interest are placed in shielded containers and returned to Los Alamos for further inspection.

I should say a few words about radiation and fallout since this is a very sensitive subject these days. The direct radiation from the reactor in the immediate vicinity will be very intense. We are operating these test devices unshielded and there will be problems of radiation heating and damage very close to the reactor. This is part of our study, to see what these are.

This radiation falls off very rapidly and at a distance of a few hundred feet there is no problem as far as material is concerned, and our control building is at a distance of about 2 miles—one can stand outside there and watch the test.

Now, contamination—and by contamination I mean the ejection of fission fragments with the coolant or propellent from such a test device—there is expected to be some. If one takes the most pessimistic case which naturally we hope will not happen, that is, you go through your complete run and the last second the whole reactor blows up and sprays all of the fissionable products into the atmosphere, in that case one is only talking about an energy release which is a fraction of a kiloton.

So we cannot believe that anything more than quite local contamination would result from this. A contribution to a large area or world fallout simply cannot be a large problem here.

I have stated in a general way how we are going about this. I suppose you would like me to come to the point and say what can be done here. Actually, I think I would be misleading you if I pretended to lay out a blueprint for a series of space missiles using nuclear power, because this is exactly what our present program is trying to determine. But I think we can say that we have no desire to re-do what chemical systems have already done, that we have some feelings which I think are quite firmly founded as to what sort of missions make sense. We are talking about payloads, I think, which are not less than 10 tons. We are talking about performance which is not less than a very long-range ICBM.

This is a point at which the best chemical systems and the nuclear systems, let us say, are competing. Beyond that, we feel that nuclear systems have a very considerable advantage.

Now, as to the upper limit, it is almost impossible to say. Certainly, as far as the reservoir of energy in nuclear power is concerned, there is no practical limit. The limitation is in how you apply this, how do you get the work out usefully. There you say, we cannot any more deal with solid materials. Then someone will propose a liquid or gaseous system and you cannot prove it will not work without doing some analysis. And perhaps you find that it indeed will work.

If this is not good enough, then one talks about the transition over into the ejection of very high velocity particles. You get very close to the ionic propulsion. In other words, we feel there is not any sharp boundary between these two areas.

This sort of atmosphere in which one tries these very advanced ideas is one of the things which makes us rather excited about this program. However, a lot of them will not work. We will not know whether they will work or not until we actually make some studies.

It is possible with a relatively inexpensive program to do quite a bit of evaluation of this sort. Now, as to whether this will all work, I would just like to make the statement that I do not believe that the senior people, at any rate, who have been spending their efforts in nuclear rocket propulsion would be doing this if they do not believe that there is a potential here for a performance which is far beyond the best chemical systems and, also, if they did not believe that the Nation would some day want to have this potential. So people are working in this. It is probably too early to make very concrete statements about what the ultimate result of this is.

I think that ends my prepared statement.

Mr. NATCHER (presiding). Doctor, you have made a fine statement to the committee and we certainly appreciate it. There are a number of questions that the members of the committee and our director would like to ask, Doctor. If it meets with your approval, we still stand in recess until 2:30, at which time we will then direct our questions to you concerning your statement.

Dr. SCHREIBER. Fine, thank you.

(Thereupon, at 12:10 p. m., the hearing was recessed, to reconvene at 2:30 p. m., same day.)

AFTERNOON SESSION

Mr. NATCHER. Dr. Schreiber, will you come around, please?

STATEMENT OF DR. RAEMER SCHREIBER, LEADER OF N DIVISION, LOS ALAMOS SCIENTIFIC LABORATORY, ATOMIC ENERGY COMMISSION—Resumed

Mr. NATCHER. Doctor, one of the main duties to be performed by this committee is to make the necessary recommendations concerning legislation pertaining to research and the problems of flight within and outside the earth's atmosphere. Have you had a chance to examine the bill which is before the committee at this time?

Dr. SCHREIBER. I have seen the bill. I have not studied it, but I have seen the main provisions.

Mr. NATCHER. Under the terms of this bill, a director is to be named by the President, to be confirmed by the Senate. What type of qualifications do you feel that the director of this new agency should have, Doctor?

Dr. SCHREIBER. He has to be somewhat of a superman, but I guess that is not a very helpful statement.

Mr. NATCHER. First, let me ask you this: Are you in favor of this agency being controlled by a civilian group, that is, having civilian control?

Do you favor that procedure, Doctor?

Dr. SCHREIBER. Anything I say in this regard, I suppose, is mostly a personal reaction. I definitely would be in favor of civilian control. My experience has been with this sort of control and I feel that you have a better continuity, a longer range point of view, than with a direct military responsibility in which the immediate problems also must be solved.

I do not know that one can make any generalities. It depends so very much on the framework in which this is set up and philosophy under which it is operated, but I would say that a civilian agency is definitely to be preferred.

Mr. NATCHER. The bill before us also provides for a board of not to exceed 17 members.

Now, basing your answer upon your connection with the Atomic Energy Commission, and knowing how that organization functions, do you believe that the board should have as many as 17 members or should it be a board of less than that number?

How do you feel about the number of members on the board?

Dr. SCHREIBER. As an advisory board, I suppose it does not matter too much except that as many as 17 members somehow seems to be an awful lot.

Mr. NATCHER. Under the bill, it provides that eight members shall come from Government agencies, with the Department of Defense to have one member, and the balance to be composed of other members to be designated.

I am inclined to agree with you as to the number. I think 17 is too many. What is the setup, as far as the Atomic Energy Commission is concerned, as to number, the operating board of the Atomic Energy Commission?

Dr. SCHREIBER. I do not think I should try to answer this. I am not quite sure I know your exact question. There are five commissioners.

Mr. NATCHER. That is the point I have in mind. You have five commissioners and they in turn operate and perform the duties necessary for this particular board.

Doctor, generally, how do you feel as far as research is concerned here in this country? Do we have the necessary number of properly trained individuals for our demands, at the present time?

Dr. SCHREIBER. I suppose it is true that the research activities that one can see when he is in the business will always exceed the number of people available to do the job. I think that everyone is concerned these days that we do not seem to be making research in science part of our life, sufficiently attractive, or that our training is not quite proper to keep up the rather large increase which we can see could be used in this way.

I do not pretend to any special knowledge in this. I find it, in general, hard to hire the sorts of people we want because there is a very intense competition for good people who have had adequate training; to look into the future, it looks as though this will continue. So all I can say is that I endorse the feeling that we must do a great deal to get better teaching and to encourage students to go in the field of science.

Mr. NATCHER. Do you feel that science should have a position in the Cabinet at the present time?

Dr. SCHREIBER. I do not feel competent to answer that question.

Mr. McDONOUGH. Doctor, is the ramjet the closest approach to the possibility of using nuclear propulsion power up to now?

Dr. SCHREIBER. Well, I am getting to matters of opinion now. You are contrasting this with a true nuclear rocket, I assume?

Mr. McDONOUGH. Yes.

Dr. SCHREIBER. I do not know what I can say one way or the other is any closer. Both of them have been worked out conceptually, and it appears that they can be done. It is very difficult to see what practical difficulties will arise in the course of development, and these can really throw off any prediction that is made at the present time.

Mr. McDONOUGH. You mean that we have used nuclear power for propelling a missile or rocket up to now?

Dr. SCHREIBER. No.

Mr. McDONOUGH. Are we not about ready to use the ramjet for our rocket plane? Are we not close to that or is this classified information?

Dr. SCHREIBER. This is not in my program. I do not know the time scale.

Mr. McDONOUGH. Could you give us an idea of the time schedule on the use of nuclear power or is that classified?

Dr. SCHREIBER. I would rather stay away from that, if I may.

Mr. McDONOUGH. In your description of the use of nuclear power for propelling rockets this morning, do you mean that such a vehicle, once it is propelled into outer space, would then be propelled by a nuclear engine to a planet or wherever you want it to go?

Dr. SCHREIBER. This is certainly one of the possibilities. I had rather avoided trying to speak of specific applications because there are many, many concepts, but the point I was trying to make in the

presentation this morning is that it is possible in principle to make these rather ambitious voyages starting from the earth and not use an excessive amount of propellant in order to get up to the velocities required for such exploration.

Exactly how this should be done, you can get many opinions and I think they are all simply opinions. You can have a combination of nuclear and chemical systems, you can have these appearing in various stages, you can have all sorts of auxiliary systems.

My main point this morning was to say all of these concepts are made easier if you have a basic system in which you can actually lift heavy payloads and get them up to the rather fantastic velocities which are required for lunar or space exploration.

Mr. McDONOUGH. Once the spaceship is in orbit, it should have some propelling power unit on it?

Dr. SCHREIBER. Yes.

Mr. McDONOUGH. Have we progressed to the point as to what kind of elements we would use in developing atomic power in such a spaceship?

Dr. SCHREIBER. I am getting a little on dangerous ground again, I am sorry to say.

Mr. McDONOUGH. Now, in your opinion, what is the greatest benefit in the exploration of outer space? Is it greater benefit for civilian economic uses or for military purposes?

Dr. SCHREIBER. I do not know that one can make a statement that one is above the other. It seems to me that there are both potential military and civilian applications to this and it depends a great deal upon what happens to the world in the next few years as to how these are weighted. Certainly one can see purely scientific peaceful applications which will justify quite an investigation here. I think it depends very much on the temperament of the country as to whether these peacetime benefits will provide enough impetus to carry on this program or not.

Mr. McDONOUGH. Do you see much benefit in transportation by spaceship?

Dr. SCHREIBER. Yes, it opens up this additional dimension essentially. I do not know that one can be specific and say it is economically feasible, this is one reason, or if you simply say we ought to find out more about space and that there are many reasons which make our interest valid and justifies support of the program.

I am sure you have been given all the reasons, weather forecasting, observation, and so on. I cannot contribute to this.

Mr. McDONOUGH. Except to obtain an additional point on it. The committee is interested in the variety of opinions of those who are actually engaged in the science of space technology and its future.

Mr. Natcher asked this question, and I am asking it in another way. Are we coordinating our scientific manpower and talents in the proper direction here or are we wasting some of it? Have we enough of it?

Now, those are three angles to one question.

Dr. SCHREIBER. To discuss the question of coordination, my own feeling is that when you are talking about a really exploratory investigation, a research project, as it were, that you can have too much coordination, you are looking for bright ideas, you are looking for basic research, and a certain amount of free wheeling I think is very

much justified in this case because I do not know that there is anyone who is smart enough to say: "This is the right pattern and no other will do."

As you approach a specific—I hate to use the word "requirement," it sounds too military—but as you approach a specific desire to accomplish a certain end, then I think the coordination is necessary and I think also that there has to be a coordination and exchange of information to prevent people who do not know the state of the art, let us say, from wasting a lot of time walking around in the footsteps of the people who are farthest ahead.

If you are then talking about a very specific job on a definite time scale, then I think you need a very strong management and you need to have someone, preferably an individual, who makes these decisions and has the power to make them stick.

Mr. McDONOUGH. And keep the nose to the grindstone, in other words?

Dr. SCHREIBER. Yes.

Mr. McDONOUGH. Insofar as the scientific manpower we have in this country, and the quality that it is in the upper levels, do we have a sufficient quantity of them now in the United States?

Dr. SCHREIBER. I have to define "sufficient," and this is a very difficult thing.

Mr. McDONOUGH. Well, does the education system need a stimulus to produce more?

Dr. SCHREIBER. Yes, I definitely think it does.

Mr. McDONOUGH. Then we should encourage the qualified youngsters in the lower grades to study science as a career in the United States. We need that.

Dr. SCHREIBER. I think we need that.

To digress for a moment, my wife is on the school board at Los Alamos, and she is very much aware of the fact that teachers in general are not paid as well as the professional people, that quite frequently in spite of the best efforts, it is not easy to find qualified teachers for the salaries that can be offered.

I do not think it is altogether a matter of salaries. I think it is the general education system where somehow we have not brought this up to the proper level. I simply say again that I endorse a feeling which I think is growing in this country, that our educational system must be given a stimulus. I do not mean just for the physical sciences. Let us not neglect the political sciences and the humanities.

Mr. McDONOUGH. In other words, we are not applying ourselves to an objective in our educational system as much as we should?

Dr. SCHREIBER. I think this is true.

Mr. McDONOUGH. There should be more concentration on an objective and less frills in the type of educational system we have now?

Dr. SCHREIBER. I am getting out of my area if I try to comment on that.

Mr. McDONOUGH. That is all, Mr. Chairman.

Mr. NATCHER. Mr. Fulton.

Mr. FULTON. Could you give us what you think is the dividing point or the difference in jurisdiction between the Atomic Energy Commission and a supposed national astronautical space agency? Where does the function of each of these agencies end so that there is no overlapping? How would you set that up?

Dr. SCHREIBER. This again is a policy question on which I am only giving an amateur answer.

Mr. FULTON. Rather than have an off-hand statement of it, would you put that in the record at this point as to what your personal views are, separate and apart from your Government position.

Dr. SCHREIBER. Let me speak of the agencies themselves. The Atomic Energy Commission, I feel, can best sponsor the rather specific researches which have to do with the development of systems for generating and transforming atomic energy.

If you are talking about a specific application, then probably the center of gravity falls toward the management of the overall system.

Now, if there is an agency set up that has responsibility for an overall missile system at the point where one has generated quite specific ideas and says "All right, we need this component which has certain characteristics," then certainly there has to be a shift of general responsibility into this new management system.

Mr. FULTON. Which one of the two agencies should work on nuclear-powered rockets and missiles or space vehicles?

Dr. SCHREIBER. I think it is a question of what stage of development you are talking about. I am going to avoid the question of whether it should be NASA or AEC, because I do not feel competent to comment on this. But if you set up a missile agency, then it must, I think, take over jurisdiction at the point where you have a quite specific objective.

The research, I think goes back to my previous comment, that when you are doing research and general development, perhaps it does not matter too much, you do not need a close control over what is done; in fact, it is preferable not to have too close control.

Mr. FULTON. With the Atomic Energy Commission engaged in developing, through governmental and private means, nuclear atomic powerplants, you would then distinguish, and on a particular project like a nuclear-powered rocket you would have the nuclear powerplant then executed or studied by the NASA?

Dr. SCHREIBER. Yes. This is assuming that NASA has been assigned this responsibility.

Now, exactly where one breaks over from one to the other, I think is very difficult to say. No doubt many words could go into a discussion of what makes appropriate sense.

Mr. FULTON. At the present time, you do not see overlapping causing a conflict in jurisdiction between the Atomic Energy Commission and the proposed NASA as recommended by this bill? That is the current legislation.

Dr. SCHREIBER. Again, I hate to repeat this, I do not feel really competent to judge this, but I do not see such a conflict, myself.

Mr. FULTON. What did you say, sir?

Dr. SCHREIBER. I do not personally see such a conflict, myself. It seems to me that this is not very different from the way in which, for example, the Atomic Energy Commission has worked with the Department of Defense on specific development work.

Prior to being in the Rover business, I was in the weapon engineering side of the picture, so I actually saw specific programs, in fact had responsibility for some of those where we worked with various Army, Navy, and Air Force agencies.

Mr. FULTON. On the particular application of the type of missile or vehicle, you would have that decision then made, as to the particular agency, between the Atomic Energy Commission and the NASA, that had the best facilities to do it?

Dr. SCHREIBER. Yes, think so.

Mr. FULTON. So that the policy would really be determined as much by facilities as by personnel, as we developed these two agencies?

Dr. SCHREIBER. And the need for a close association between this particular development and all of the other pieces which would have to flow into it.

Mr. FULTON. There has been testimony here of various projects which are being carried on at Los Alamos and other installations on atomic and nuclear research and development.

One witness who testified on this particular subject was Dr. Merkle of California, whom you know. I believe, too, there is a Colonel Armstrong in the room. What is his title?

Dr. SCHREIBER. Colonel Armstrong?

Mr. FULTON. Yes.

Dr. SCHREIBER. He is the deputy to General Keirn as head of the Aircraft Reactors branch in the Reactor Development Division of AEC.

Mr. FULTON. Have either of you gentlemen had any cause for concern as to the violation of any secret or classified material in the testimony so far, on atomic and nuclear programs, and especially referring to Dr. Merkle?

Dr. SCHREIBER. No. I do not know that I have seen all of the testimony, but I have not seen anything which appeared to me to violate any security.

Mr. FULTON. Does that also follow for Colonel Armstrong, who is here in the room, may I ask?

Colonel ARMSTRONG. I read Dr. Merkle's testimony, and I would say he came awfully close, but he did not violate any security.

Mr. FULTON. Would you say the same?

Dr. SCHREIBER. I would not put it as being quite as close as did Colonel Armstrong.

Mr. FULTON. But there is no violation of security?

Dr. SCHREIBER. That, I think, is quite true.

Mr. NATCHER. Mr. Ford.

Mr. FORD. No questions.

Mr. NATCHER. Mr. O'Brien.

Mr. O'BRIEN. I have one question.

This committee, to a very great extent, is treading on virgin territory. Occasionally, our questions have strayed away from the immediacy of the legislation we have before us.

Suggestion was made yesterday by Dr. Kantrowitz that we needed more of a spirit of adventure in this field. Do you believe it would be possible or desirable to work out a plan under which we could have an area for basic research, sponsored and supported by the Government, which would not be tied directly to specific projects?

Dr. SCHREIBER. I will certainly subscribe heartily to the feeling that the effort which goes into such a program must include a great deal of basic research.

As I tried to say this morning, the work which I tied to the Rover program on high temperature investigation materials actually is not

limited to the nuclear rocket propulsion application. This sort of work is needed for any of these applications, and whether administratively this sort of research should be tied into the same agency as the specific projects again I think is a rather serious policy question which depends—well, it has no simple answer. You have to ask what is the overall directive of this particular agency. Are they to do some things immediately and also plan for the future?

Are they set up for a restricted length of time to do a specific mission and so on?

I just want to add that there is a good technical reason, I believe, for trying to keep these tied together in some sort of fashion because I think that you can have very good research without having it be completely random.

Mr. O'Brien. I was not thinking completely at random, but I have been impressed by the testimony we have received as to the amount of basic research there has been in connection with these various projects. I have been impressed with the fact that the military has not strangled basic research, but the thought did occur to me that while we are working on these various projects, each with its own basic research, that it might be desirable in this agency to have an area in which scientists would work. Those scientists would have available to them the developments in these several fields and they would be permitted to conduct basic research in that spirit of adventure that Dr. Kantrowitz mentioned.

It was just a thought that occurred to me, as long as we are creating this new agency, as long as we are all anxious to move forward as rapidly as possible, that that might be possible, especially in view of the fact that so many witnesses said that the cost of basic research is not tremendous, does not involve very much hardware, and so forth.

I have one other question. So many of us have asked about this educational question. I realize it is the primary problem of another committee or committees, but I think it is part of the rounded picture.

Do you not think that our big trouble today, if we have a lack of youngsters aspiring to scientific careers, does not lie entirely with the education system or with the pay of the teachers, but the lack of desire on the part of the youngsters and their parents?

What I have in mind is this: Someone said to me during the noon recess that many of our grandfathers worked very hard as laborers, if you will. They wanted their children to become mechanics, to have a trade, and many of them did. Then those mechanics and tradesmen in turn wanted their children to be doctors or lawyers and to acquire the polish and prestige of a profession. Apparently, we have reached a certain point where we have not been advancing and it seems to me that these professional men now desire their children to be bond salesmen or insurance salesmen, because that is the shortcut to a quick buck.

Do you not believe that this breakthrough into outer space itself is going to inspire the young people and their parents to demand from the educational system the opportunities for a fuller scientific education?

Dr. Schreiber. Well, I can hope that this will happen. I suppose it will not happen without a fairly deliberate program of education. I do not mean child education but adult education essentially, to make

the general public aware of, I suppose, 2 or 3 things. One is the spirit of adventure, as you said.

Another which surprised me a little bit is that people do not believe that technical people can make a comfortable living, they have to starve in an attic, and this somehow has to be dispelled. I do not know of any single way of doing this, but I do think that a discussion of the world of tomorrow, if you will, but not expressed in science fiction language, is part of this educational program.

Mr. O'BRIEN. I think this very breakthrough is going to produce more future scientists than any of us realize, just as we had multiplicity of law schools and medical colleges as a result of the ambition of some of our fathers.

Thank you.

Mr. NATCHER. Mr. McDonough.

Mr. McDONOUGH. Pursuing the thought of Mr. O'Brien, there are fewer scientists who are sacrificing the better things of life than there are artists, sculptors, writers, and actors, are there not?

Dr. SCHREIBER. That is true.

Mr. McDONOUGH. However, those people devoted to the particular arts, artists, painters, sculptors, writers, actors, will go to great extremes to stay in their professions, in spite of the fact that they cannot eat, cannot sleep so well, or wear fancy clothes, while a scientist, if he is even an amateur or less professional than the better ones, will find a job somewhere in most cases?

Dr. SCHREIBER. In most cases, yes.

Mr. FULTON. I want to thank you for your good testimony and want to say that it has been very enlightening to us.

In conjunction with the testimony of the witness who spoke of the comments of Cicero on space, I would like to put in the record his comments from two volumes which I have obtained from the Congressional Library.

Mr. NATCHER. Without objection, it is so ordered.

(The information referred to follows:)

Danby, Wm., *The Somnium Scipionis of Cicero (and an English translation of it, with notes).*
Exeter: E. Woolmer, 1829, pp. 11, 13.

"* * * Then looking around me, I beheld a shining circle, of the most dazzling brightness, and surrounded by flames, which we, as having been taught by the Greeks, call the milky way; from whence all the other illustrious and wonderful objects were open to my view. Among these were stars which we have never seen from our earth, and of a magnitude of which we have no idea; and among these was that very small one, which, being the lowest in heaven, and nearest to our earth, shone with a borrowed light. The spheres of the stars far surpassed that of the earth in magnitude; and the earth itself appeared so small, that I was ashamed of our empire, which seemed but a point in it."

Mr. NATCHER. On behalf of our chairman, Mr. McCormack, and other members of the committee, we want to thank you for your appearance and for the fine statement you have made to the committee. You will have a chance, Doctor, to go over your testimony. Any suggestions that you have to make concerning this legislation that you did not make in your testimony before the committee, you are privileged to add. We shall appreciate any recommendations that you make.

Thank you very much, Doctor.

Dr. SCHREIBER. Thank you.

Mr. NATCHER. At this time we have with us Dr. Stanislaus Ulam, Research Advisor of the Office of the Director of the Los Alamos Scientific Laboratory of the Atomic Energy Commission.

Doctor, will you come around and have a seat? We are delighted to have you at this time. Do you have a general statement to make?

STATEMENT OF DR. STANISLAUS ULAM,[17] RESEARCH ADVISOR, OFFICE OF THE DIRECTOR, LOS ALAMOS, N. MEX., SCIENTIFIC LABORATORY, ATOMIC ENERGY COMMISSION

Dr. ULAM. No, I would like to say it is a great privilege and honor to be here and perhaps make a few remarks of a general type.

Mr. NATCHER. Go right ahead.

Dr. ULAM. It seems to me that the business of the proposed agency and the subject of discussion of this committee will concern nuclear propulsion.

Now, it is my own personal opinion that the future of space navigation and astronautics will more and more, and soon—I will go into time scales later—involve these novel matters of releasing energy, and the motors and the vehicles cruising sometimes in the near future in space will be nuclearly powered.

I say this because I noticed in previous testimony, on previous days, there was an undertone of omission of this very vital and substantial part of the program, partly because certain things cannot be said, they are classified; the technical details.

Now I will not go near those regions, but no doubt, it is not a question of conjecture nor of optimism, but one might say it is mathematically certain that it will be the nuclearly powered vehicle which will hold the stage in the near future. That is not to say, and I want to emphasize it, that one should not pursue all the presently conceived and proposed chemical ideas as much as possible. That has been worked on for a long time, they are older historically and technologically, and by all means all of the work that has been discussed in detail by various speakers should go on.

But, as I said before and I repeat it again, the question of nuclear propulsion, is not a side issue; it will be the main means in the near future to obtain these aims.

The ion propulsion and the other schemes mentioned here briefly will also play a role, perhaps later. That to me seems to be the natural order of things. The reasons are very simple.

As you have heard from General Boushey and Dr. Schreiber, the ratio of energies contained in an amount of matter, chemically, between that amount which is contained chemically and the nuclear amount, is enormous. Nuclear energy is millions of times greater. The question is how to release it without burning the whole vehicle.

Now, even the modest original proposals which, if you want schemes somewhat obvious (to everybody who realizes the potentialities of nuclear energy) when realized will be vastly better than any chemical means.

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[17] Ulam, Stanislaw Marcin, scientist; b. Lwow, Poland, Apr. 13, 1909; s. Josef and Anna (Auerbach) U., M. A., Polytech Inst., Lwow, 1932, Dr. Sci., 1933; m. Francoise Aron, Aug. 19 1941 1 dau., Claire Anne. Came to U. S., 1936, naturalized, 1943. Vis. mem. Inst. Advanced Studies, Princeton, 1936, fellow, Harvard Soc. Fellows, 1936–39; lectr. math Harvard, 1939–40, asst prof. math U. Wis., 1941–43; staff mem. Los Alamos Sci. Lab., 1943—, prof U So Cal., 1945, vis lectr Harvard, 1951 · vis. prof. Mass. Inst. Tech., 1956–57. Mem Am. Math. Soc., Am Phys. Soc. Am Acad. Arts & Scis., Contbr. articles profl jours. Office Box 1663, Los Alamos Scientific Lab., Los Alamos, N. M.

You have heard the technical expressions: The thing is measured in specific impulse, which simply means the velocity of the stuff you eject. The present chemical velocities correspond to specific impulses of, say, 250. The absolute theoretical limit of chemical propulsion is 400.

On the other hand, the most modest initial nuclear planning starts with 750 and goes on to numbers vastly greater than that.

Mr. McDonough. You say the absolute is 400?

Dr. Ulam. The theoretical limit of chemical reaction is 400.

Mr. McDonough. Four hundred what?

Dr. Ulam. Units of specific impulse which means, let us say, that the thing you eject will have a velocity of 4 kilometers a second.

Now, the nuclear specific impulse which is envisioned in the Rover project is 750 units. It is not the difference between 750 and 400 which you might say is hardly a ratio of 2. This ratio goes into an exponent of a number called "e" which is 2.72. It is a very important number in mathematics. It is as important as pi. It is important in logarithms.

I could give you a short lecture and explain to you what it is all about. At any rate, there is a ratio of 750 to 350 that goes into the exponent of the number "e." For example, e to the third power is about 20. That means the following thing: That if you have 3 times the specific impulse, say in nuclear propulsion, than you would have chemically, then the ratio of the final pay load to the whole initial weight of the vehicle and the fuel will be e cube times or 20 times better.

In other words, if, by any (somewhat conventional, present) means you can put a ton in a satellite orbit using a vehicle initially weighing 100 tons, you have payload to fuel ratio of 100 to 1. With nuclear propulsion you could diminish this ratio to something like 8 to 1 or less, say 4 to 1, so it would take you only 8 tons to put 1 ton, or for 100 tons initially you could have 12 tons as a final weight of the vehicle, and so on.

There is almost no limit, theoretically, to the economy in the ratio between the initial and final weight which you can achieve nuclearly.

Mr. McDonough. That you can achieve by nuclear power?

Dr. Ulam. Yes.

Mr. Fulton. To put that in more simple laymen's terms, 1 pound of nuclear substance for generating power is equal to about 2,000 tons of coal, is it not?

Dr. Ulam. Yes, something like that. It is a factor of over a million. You mentioned a factor of 4 million. Two thousand tons is 4 million pounds.

Mr. Fulton. If we had some sort of chemical that we were going to put up there in the space vehicle in order to have it ignite or explode, we would likewise have to have another chemical element with it which would about possibly double the weight, a hypergolic fuel, would we not?

Dr. Ulam. I do not quite understand the question. You want to carry the chemical fuel into the satellite?

Mr. Fulton. We have to have another fuel with it to make it explode or ignite when we are out of the air?

Mr. Ulam. It has to carry the whole thing.

Mr. FULTON. You have to really carry double in the chemical fuel when you are beyond the air, when there is not enough oxygen to ignite it, so you have to assume hypergolic or ignition-contact fuel.

Dr. ULAM. You have to eject back of the vehicle some kind of a mass. One great advantage of nuclear propulsion is that you can eject light material, like hydrogen. Now, that is a technical point which involves some little mathematics. It pays to eject light stuff.

Mr. McDONOUGH. You mean lightweight material?

Dr. ULAM. Yes.

Mr. McDONOUGH. Hydrogen, of course, would be the lightest?

Dr. ULAM. Yes. And that you can do if you use nuclear heating of the hydrogen and put it to high temperature and out it goes, and it gives a thrust to the vehicle.

Now, there are other methods and ideas for nuclear propulsion, some rather exotic but very promising, but I cannot go into details.

Mr. FELDMAN. Doctor, I do not mean to interrupt you, but what is the danger from radiation in such a program from the use of nuclear reactors for propulsion?

Dr. ULAM. You mean in case of manned or unmanned vehicles?

Mr. FELDMAN. Both.

Dr. ULAM. If you have an unmanned vehicle, there is no danger whatsoever because the damage to materials is absolutely insignificant.

Mr. FELDMAN. Would there be any pollution of the air?

Mr. ULAM. On the takeoff, you mean?

Mr. FELDMAN. Yes.

Dr. ULAM. Extremely little. The energy required to start propelling the vehicle is very, very small compared to the smallest atomic bomb that was ever shot off, extremely small. In fact, one could conceive, one has conceived manned vehicles, objects weighing many tons, propelled nuclearly and with an expenditure of fissionable material so small that there would not be, seemingly, any danger to inhabitants of the vehicle if they had some shielding.

Mr. FELDMAN. How about the manned vehicle? The same way?

Dr. ULAM. Apparently it will not be excessive. There are ways to do it.

Mr. FELDMAN. Is there any standard of measurement or any criterion or is this a problem at all in connection with the development of the nuclear submarine?

Mr. ULAM. The nuclear submarine is a heavy object which has a lot of shielding, and nuclearly propelled rockets in some years, let us say in 10 or 20 years, will be so big that the shielding will not be a problem either.

I have talked a bit too much perhaps. I merely wanted to answer questions, but I did want to make this point that nuclear propulsion is not something far away in the future or a speculative dream, but concrete things are being done now. More ambitious, but still concrete looking things are being planned after that.

Mr. FELDMAN. I did not mean to cut you off. I wanted you to continue this fact because it is very interesting.

Dr. ULAM. I am about to finish this preamble. I would like to answer questions if I may.

Mr. NATCHER. Mr. Chairman.

The CHAIRMAN. No questions.

Mr. NATCHER. Mr. O'Brien.

Mr. O'BRIEN. Doctor, as I understand your proposal, we should stamp "urgent" on this question of nuclear propulsion without in any way standing still in the meantime in the other fields, is that correct?

Dr. ULAM. Absolutely.

Mr. O'BRIEN. Whether it is this agency or whatever agency of government, they should push nuclear propulsion as rapidly as possible?

Dr. ULAM. That is my personal feeling, yes.

Mr. O'BRIEN. I have just one other question.

We have discussed from time to time the peaceful exploitation of outer space. We have heard mention of the weather and communications and also transportation. I am quite interested in that. Would you say that before outer space transportation could become really feasible, we would have to develop nuclear propulsion?

I am thinking in terms of transporting caravans of cargo, we will say, from New York to London.

Dr. ULAM. Yes, apparently if one wants very heavy satellites or floating laboratories or observatories, nuclear power is the way to do it.

Mr. O'BRIEN. And perhaps the only way, if you are going to get into caravans of vehicles traveling through the sky?

Dr. ULAM. Yes. All these things seemed like complete fantasy some years ago, let us say 15 years ago. Strangely enough, they are within reach of technological realization.

Now, you mentioned other things. The weather control first involves the ability to calculate or predict weather which we do not have yet. That hinges on other things, on theoreticians who are able to calculate such flows and the development of computing machines, and so forth. For observations of the weather pattern from the upper atmosphere, you do not need to go to the moon for that, but if you have good big satellites which act as observatories, they will enable us to understand how weather behaves now, and this is a necessary step in order, some years later, to try to influence the weather.

The question was asked this morning of General Boushey, Does it have any value or will the investment pay?

It seems to me it is obvious that the ratio is almost infinite; anyway, if it will enable us to improve and control weather, the value of it should be measured in untold billions. This will revolutionize, of course, sometime, life on this plant.

That is just one thing. Then of course, what the future holds more remotely, nobody knows, but it is an old dream of mankind, it is certainly something of tremendous scientific interest for astronomers and others, to be able to have laboratories or observatories cruising in space, or perhaps even people doing that.

Mr. FELDMAN. Would you liken that to the experience in the atomic energy field with which you were well acquainted?

Dr. ULAM. Yes.

Mr. FELDMAN. I understand the investment there has been in excess of $14 billion, but the payoff in isotopes alone has more than canceled out the investment.

Dr. ULAM. I cannot judge the costs or value. Certainly the medical value alone is very great. Much of the expense in atomic energy can

be justified on quite different grounds, namely military necessity. It is hard to measure. The peacetime benefits in time will be enormous.

Mr. FELDMAN. The reason I mentioned that is because this project will cost a great deal of money, but in return for it, there will be an enormous quid pro quo.

Dr. ULAM. Yes.

May I say the money involved in developing nuclear propulsion is of an entirely different order of magnitude than the development of atomic nuclear energy, which was much more. It would not be necessary, seemingly at least, to have any billions of dollars, but much less will suffice to develop the principles and then prove by experimentation certain ways of establishing nuclear motors. But the project will not end there. There will be other ways, already conceived and being calculated—I can not go into details—going beyond the present Rover project and all these will certainly occupy the proposed agency or should occupy it to some extent. I wanted to say that the sums necessary to develop nuclear propulsion are much smaller than the cost of atomic energy in general.

Mr. O'BRIEN. Doctor, do you think that our educational system needs a little more propulsion to produce the number of scientists we are going to need in the future?

Dr. ULAM. My own feeling is, indeed, as has been said by so many people, the times are such that it is necessary to have more scientists, not only because of external danger to the country, but the development of technology, the peaceful technology.

The Pandora's box has been opened, the whole thing is developing now at a much faster rate, and I think it will be necessary and I think it will happen that we will have more young people trained as scientists at all levels, I mean the necessary great masses of "sergeants", and more "geniuses" will come.

Mr. O'BRIEN. You think more will come into science because of the fascination of this subject?

Dr. ULAM. Yes. Science is something that many people think is worthwhile for its own sake.

Mr. O'BRIEN. Thank you very much, Doctor.

Mr. NATCHER. Doctor, have you had a chance to examine that portion of the bill before the Committee which makes provision for research into the problems of flight within and outside the earth's atmosphere?

Dr. ULAM. Yes, I read it. I canont say that I studied it in any detail. There are some cryptic things that I do not understand, but I understand the general tenor of it.

Mr. NATCHER. From your experience in connection with the Atomic Energy Commission, do you feel that such an agency should be a civilian control agency?

Mr. ULAM. My own feelings would be yes, the general direction preferably civilian, just like AEC, but in close touch with the military. It seems to me it is necessary to have the military interest constantly in mind.

Mr. NATCHER. We value your judgment and that is the reason we are asking you these questions.

This is a bill that the Committee, of course, is vitally interested in, and we want to submit to the House the proper legislation. How do

you feel about the Board provided for under this bill, Doctor, that calls for membership not to exceed 17 members?

How do you feel about this number?

Dr. ULAM. I think Dr. Schreiber said about the same thing I am going to mention. If it is an advisory board, then the number does not matter too much. If it is a governing board, it seems very large. The number 17 seems unwiedly.

By the way, I do not know what is planned, but my personal feeling would be that the AEC, just because nuclear propulsion is going to play such a role, should be on it or very strongly interacted with this agency.

Mr. NATCHER. The bill further provides for a director. In your opinion, should this director be a scientist, or what should his qualifications be? What suggestion would you have to make along that line?

Dr. ULAM. I think he should have the best scientific advice or have scientific deputies. Obviously there are questions of administration and finance on which I am not competent to say very much, but just by commonsense the man must be a "man of the world" also, in addition to all the other qualities he must possess.

Mr. NATCHER. Doctor, do you have any other suggestions to make concerning proposed legislation setting up this particular type of agency? Do you have any observations you want to make to the committee?

Mr. O'BRIEN. I am sure the doctor's testimony will stand on its own merits, its own weight in the record, but I think for those who read it, it is only fair to state—you do not have to state it, Doctor—that you probably had as much to do with the development of the hydrogen bomb as any man in the world. That is my statement. you do not have to agree or disagree with it.

Mr. NATCHER. Mr. McDonough.

Mr. McDONOUGH. You have been a scientist all your life?

Dr. ULAM. Yes.

Mr. McDONOUGH. Do you think that in the administration of this agency scientists should be unrestricted in direction on basic research; they should be free to think and act without too much direction?

Dr. ULAM. Absolutely. It is one thing to think out schemes. It is entirely different to put them into being or practice. That is where you have to have practical contributions and practical people.

Just to give an example, suppose the country were willing to spend on things of this sort—$100 million or $500 million, but not $500 billion because it is out of the question, I am just stating an extreme case—these projects have to be considered in relation to other projects going on in the country, and all the other facts of life.

Mr. McDONOUGH. A good scientist is not extravagant is he? He is conservative in his views?

Dr. ULAM. Mostly, yes.

Mr. McDONOUGH. His objective is always to find a better way to do something and to reduce the amount of effort that has been put into doing that thing in a previous manner?

Dr. ULAM. Yes, economy of thinking, certainly.

Mr. McDONOUGH. So there is not too much thinking so far as giving free thought to the scientist. He is not going to be as extravagant as some bureaucrats around here?

Dr. ULAM. Thought is always free.

Mr. McDonough. We must recognize the temperament of a scientist in his studying of the subject matter.

Dr. Ulam. Yes. There are all kinds of temperaments in science.

Mr. Natcher. Mr. Fulton.

Mr. Fulton. Doctor, we are glad to have you here. Are we in this country doing enough on the exchange of scientific knowledge on a worldwide basis?

Dr. Ulam. I do not know much about the extent in detail with which this is going on. It is nothing new. There always was some exchange of scientific knowledge.

Mr. Fulton. Do you find ready access to a sufficient volume of reference work on the subject you are working on, atomic nuclear power?

Dr. Ulam. I happen to, but that is not a good case since I have all the necessary clearance and I have complete access.

Mr. Fulton. The problem comes up on nuclear power as to the magnitude of the fuel that would be required. If you take a thousand people, that would be 150,000 pounds, 75 tons. You add another 75 tons for the vehicle. What would the weight be in ordinary terms of nuclear fuel that will be required to transport that vehicle so loaded to the moon?

Dr. Ulam. You want to have a final weight, let us say, of 200 tons, to be generous with providing some instruments.

Mr. Fulton. That would take a thousand people to the moon.

Mr. Ulam. Let us say with all the necessary books and instruments. All right, if it is the nuclear fuel itself, the uranium itself would not weigh much at all.

Mr. Fulton. How much? Ounces or pounds?

Dr. Ulam. Certainly kilograms.

Mr. Fulton. You estimate.

Dr. Ulam. To make a guess, a couple hundred kilograms.

Mr. Fulton. What part of a pound is that for us Americans?

Dr. Ulam. A kilogram is 2.2 pounds. Just multiply by two.

Mr. Fulton. You say how many kilograms?

Dr. Ulam. I am just saying, in an order of magnitude, a couple of hundred of kilograms or, say, 500 pounds or a thousand pounds. All these are small amounts.

Mr. Fulton. So it would really take a half-pound per person to go to the moon?

Dr. Ulam. No, that is the fuel element which is uranium. You have to eject from the vehicle some mass to propell. Suppose you had a lot of hydrogen stored, liquid hydrogen or some such light substance which you heat up by means of this nuclear fuel and eject it. Of that, you would have to have vastly more than kilograms.

If you want 200 tons at the end, you will have to have, say, with some very good nuclear scheme, say 600 tons or 800 tons or a thousand tons of this inert matter propelled.

You first have the energy generation, uranium or plutonium or what have you. That does not require much material, but you have then to eject some inert mass.

Mr. Fulton. Do you not simply have to eject it until you come to the edge of the earth's atmosphere and then coast to the moon?

Dr. Ulam. No. You have to achieve the so-called escape velocity, or if you are less ambitious, satellite velocity, the kind of velocity

which our Vanguard has or sputniks or Explorer. That is a very sizable velocity and to get that in your final 200 tons, you have to throw out, let us say, a thousand tons of some stuff. But that is nothing at all frightening in any way, or impossible.

Mr. FULTON. How many pounds per individual then do you visualize for both the nuclear fuel and the ejection material in order to get to the moon?

Dr. ULAM. If you want to put a pound on the moon, you have to remember that this pound of final payload has to have with it some kind of case or shielding or instrumentation. But at any rate, for the final pound of whatever you put on the moon, you have to throw out during the process of acceleration of the vehicle by nuclear means, let us say, just to make a round figure, 10 pounds.

Mr. FULTON. Now, is it not a case of ordinary chemical fuels and oxidation materials as well as the solid propellents on the third stage? It takes about a thousand pounds to get one of the Vanguard satellite pounds up?

Dr. ULAM. Yes. This ratio, as I said before, is much greater for chemical fuels because they do not have as much energy.

Mr. FULTON. So we clearly then should proceed, as has been suggested, on an urgency program to develop these nuclear fuels and propellents in order to travel far in outer space?

Dr. ULAM. Yes. Perhaps if I might qualify the word "urgency," one should do as much as is possible or feasible now without disrupting other projects.

Mr. FULTON. Yes, I would agree with that.

Dr. ULAM. In my opinion, to further this extremely important, in my view (nuclear) means of getting into space using nuclear power.

Mr. FULTON. The question comes up on the proposal for the nuclear shot in the Pacific. Do you favor this country going ahead with the shots, in view both of the danger of fallout as well as the security factors?

Dr. ULAM. That is an entirely different question, which is not related to nuclear propulsion.

Mr. FULTON. Would you say go ahead with the Pacific test just the same?

Dr. ULAM. Yes, it has been decided to.

Mr. FULTON. And there is no extreme danger either to the United States or the people of the world?

Dr. ULAM. From these shots, no. If you extrapolate over the next 5,000 years and look at cumulative effects, that is an entirely different question, but from one series of shots apparently—you see, it is not in my field; I do not know about the genetic damage.

Mr. FULTON. Yes, but you do know about the fallout?

Dr. ULAM. I know about the fallout. From one series of shots like that, there is not much danger to humanity. The danger is from the long-range extrapolation of this program.

Mr. FULTON. The question comes up on the use of velocities. Is not one of your big problems with a nuclear power to start at a velocity which will not be so large at the beginning that it destroys either the vehicle or the people?

Dr. ULAM. You mean the acceleration should not be too violent if you have people in it.

Mr. FULTON. That is right.

Dr. ULAM. Human beings can stand accelerations of the order of gravity, of which the unit is 1G, or even more, 2G, or 3G.

Mr. FULTON. The Vanguard starts at 2G's. Could a human being stand that?

Dr. ULAM. Yes. One can stand for a short time much more. You have read in the newspapers about experiments with people subject to 20G or more just once. But 2G's certainly seems harmless. In fact, in planes taking sharp banks, you get more.

Mr. FULTON. So you see no limit on acceleration on attaining speeds that are much beyond our comprehension, if we can build the proper powerplant to control it?

Dr. ULAM. No, there is a limit of acceleration that you can stand, but even with modest acceleration you can achieve in time extremely high velocity. Even with 1G which we stand here in this room all the time, with that if you let it go on for some minutes you would achieve high velocity.

Mr. FULTON. Let us talk about those extremely high velocities for a minute. In the ordinary sense of velocity as you see it, one vehicle added to another, V_1 plus V_2 is an idea of high velocity?

Dr. ULAM. Yes.

Mr. FULTON. Do you take into the equation the V_1 and V_2 or the denominator of one plus the first vehicle squared times the second vehicle squared?

Dr. ULAM. If I go 50 miles an hour in the car and something moves 10 miles inside my car, this thing moves 60 miles, you just add it. But suppose you move a couple of hundred thousand miles an hour, say 100,000 miles an hour, and in this vehicle something else moves again; well, in these velocities still much more extreme than anything considered here, very close to the velocity of light, you do not add them up any more. There is another formula.

Mr. FULTON. You say the velocities are in a field where you cannot take our ordinary velocities and just simply add them together; is that not right?

Mr. ULAM. Yes. But we do not have to worry; we are not that far yet. That will be another century when we try to approach the velocity of light in these vehicles, which indeed may come but not in this century; that I will guarantee.

Mr. FULTON. So your nuclear proposals are all within the velocities we are thinking of practically?

Mr. ULAM. Yes; this velocity is still far lower than the velocity of light, which is 300,000 kilometers per second.

Mr. FULTON. Suppose I am in a capsule going at the velocity of light at 186,300 miles a second, and throw a baseball forward 30 miles an hour. What happens?

Dr. ULAM. It still goes at the velocity of light.

Mr. FULTON. I could not throw it.

Dr. ULAM. Yes; you can.

Mr. FULTON. But it will not go anywhere?

Dr. ULAM. Yes; it will, but it will be the same as yours——

Mr. FULTON. The point I am making is this: We are coming into the problems of velocity and speeds that we cannot reason with our ordinary earthbound arithmetic figures; is that not right?

Dr. ULAM. Yes. But that is not yet in sight. Unless you want to go to other stars——

Mr. FULTON. That is what we are talking about.

Dr. ULAM. As long as we are in the solar system, people talk even of Mars or Venus or Jupiter, all these distances are relatively small compared to distances to stars.

Mr. NATCHER. Mr. Ford.

Mr. FORD. Doctor, will the apparent features of nuclear propulsion in this field have any sizable impact on the configuration of our missiles or satellites?

Dr. ULAM. In what sense?

Mr. FORD. As to size, shape, or any of the other features that are involved in the construction of a missile or satellite.

Dr. ULAM. You mean whether the missile will be like a long cylinder surmounted by a cone?

Mr. FORD. Yes.

Dr. ULAM. It is hard to say. They may be pear shaped, they may be saucers in the future. I do not think it matters.

Mr. FORD. The work we are doing on the configuration and structure and the metal, and so forth, on the vehicles themselves will not be adversely affected by the development of nuclear propulsion?

Dr. ULAM. No; not at all.

You see, once you are in free space, the shape does not matter. If there is no resistance of atmosphere, you do not need to have any special shape of the nose cone. You must have read in the newspapers that people plan to throw out a big aluminum sphere which will then cruise around the earth, unimpeded by resistance of the air, it is so high up.

Mr. FORD. So the work we are doing in all these other areas will not be adversely affected by the change in the means of propulsion. If what you are advocating comes into being, we will still be able to use it?

Dr. ULAM. Yes; it remains useful no matter what other things take place.

Mr. NATCHER. Mr. O'Brien.

Mr. O'BRIEN. This question has nothing to do with the problem at hand, but I have not been able to sleep nights because I have not had the answer yet to what happens to that baseball when it is thrown up there. Does it actually leave the thrower's hand?

Dr. ULAM. First of all, if you want to be quite technical about it, no object can quite travel with exactly light velocity. You can approach it, but you cannot travel exactly. You would need actually an infinite amount of energy. You can travel a few kilometers per second less than light, expending energy enormously but not quite infinitely.

Mr. O'BRIEN. Where is the baseball? I am still wondering. I am up there traveling at that speed and I want to throw the baseball. Will it leave my hand?

Dr. ULAM. Yes.

Mr. O'BRIEN. How far does it go?

Dr. ULAM. Just as far as if you had thrown it in the Yankee ballpark.

Mr. O'BRIEN. I have thrown it beyond the speed of light?

Dr. ULAM. No.

Mr. McDONOUGH. Instead of using a baseball, suppose you travel 186,000 miles a second.

Dr. ULAM. Yes.

Mr. McDONOUGH. That is the maximum, or we will say less than that, whatever you say, and you shoot a revolver in the forward direction in which you are traveling. Where will the bullet go?

Dr. ULAM. It will go forward. It will leave you at the same kind of speed with which the bullet leaves the revolver now. Its velocity with respect to an observer standing outside will not exceed that of the velocity of the light.

Mr. McDONOUGH. You mean it will just drop out of the gun?

Dr. ULAM. No. We are already traveling right here together with this whole room, with a velocity which is something like 30 kilometers, over 20 miles a second around the sun. The sun itself moves around the galaxy with a very great speed, several hundred kilometers a second. For all we know, our galaxy might be going thousands of kilometers a second in space with respect to some other observer. We are totally unaware of this great speed.

If you speak of velocities, we must speak with respect to an observer who is measuring this velocity.

Mr. McDONOUGH. Can you conceive of any faster speed than 186,000 miles a second?

Dr. ULAM. One can conceive it, but if you believe in the theory of relativity, which most physicists now believe, no material object can acquire and nothing can surpass the velocity of light in vacuum.

Mr. McDONOUGH. Is not the velocity of light based on the ability of man to see and observe? It is measured on the optical vision of man?

Dr. ULAM. Yes. It was done a hundred years ago by a toothed-wheel arrangement.

Mr. McDONOUGH. The speed of light cannot be measured by any other means than by the eye of man?

Dr. ULAM. Ultimately, yes; the human eye has to observe something, but it (velocity of light) has been measured very accurately by now.

Mr. McDONOUGH. So to a person who cannot see as well as another, the speed of light might be different than 186,000 miles a second?

Dr. ULAM. It is not a question of speed.

Mr. McDONOUGH. It is a question of perception?

Dr. ULAM. Yes.

Mr. FULTON. There may be stars we have never seen because they are receding from the earth at a speed greater than the speed of light?

Dr. ULAM. Yes; beyond the horizon of the universe which is very far away.

Mr. FULTON. In order that Mr. O'Brien can figure out the speed of the baseball, I think we should give him the formula as the velocity of the platform he is on, the capsule he is in, plus the velocity of the baseball, and draw a line for a fraction, and then under that put the figure 1 plus the velocity of the platform or capsule you are in squared times the velocity of the baseball squared.

Mr. O'BRIEN. I followed the gentleman very, very carefully except that I left him at the first point. I would not be in that capsule.

Mr. FULTON. Is that right, sir?

Mr. O'BRIEN. I would like to suggest, Doctor, that this problem of baseball is so far in the future that you can see no way now that it would help the Senatorial pitching staff.

Dr. ULAM. Yes. The next century.

Mr. NATCHER. Mr. Feldman, do you have any questions?

Doctor, on behalf of our chairman, Mr. McCormack, and the other members of the committee, I want to thank you for your appearance and for your fine statement. We appreciate your coming before the committee at this time.

Doctor, in examining your testimony, if you have any suggestions you would like to make or if you want to incorporate any statements which will help us with our duties, as far as this particular legislation is concerned, we will appreciate it.

Dr. ULAM. Thank you very much.

Mr. NATCHER. Thank you, Doctor.

Our next witness is Mr. Krafft Ehricke. He is chief of the preliminary designs and systems analysis of the astronautics division of Convair, San Diego, Calif.

Do you have a prepared statement you would like to make at this time, or a general statement?

STATEMENT OF KRAFFT EHRICKE, CHIEF, PRELIMINARY DESIGN AND SYSTEMS ANALYSIS, ASTRONAUTICS DIVISION, CONVAIR, SAN DIEGO, CALIF.

Mr. EHRICKE. Yes, sir. I have a prepared statement, Mr. Chairman, and with your permission I would like to read it, sir.

Mr. NATCHER. Go right ahead.

Mr. EHRICKE. Thank you, sir.

Mr. Chairman and members of the committee, when I was invited to appear before the House Select Committee on Astronautics and Space, it was suggested by your director and chief counsel that I consider primarily the subjects of rocket vehicles (including those equipped with advanced propulsion systems) and space operations.

URGENCY OF SPACE CAPABILITY

First, I would like to note that I am in full agreement with the statement of the President's Science Advisory Committee of March 26, 1958, emphasized by the President in his message to Congress of April 2, 1958, regarding the factors which urge active steps to advance space technology namely, (1) man's drive to explore the unknown, (2) the need of military vigilance in space as in all other areas accessible to potential opponents as well as to us, (3) national prestige, and (4) scientific progress. I may therefore proceed on the premise that space flight is a desirable goal and concentrate on problems and aspects of how an adequate United States space capability can be established, economically, as well as without further delay.

ADEQUACY OF SPACE CAPABILITY

With adequate space capability I mean:

(1) Scientifically: That we must stay abreast in space science—that is, not in all specific missions, but in the average.

(2) Militarily: That we must be as capable as any other nation.

(*a*) To operate weapon systems in space with missions pertaining to the earth's surface.

(*b*) To conduct earth-to-orbit and orbit-to-orbit warfare, both in the defensive and the offensive sense of the term.

With all due recognition of the legitimate needs of other important national projects, we must strive to attain leadership in the development of space flight true to the technical, scientific, and pioneering heritage of the Nation.

EMPHASIS OF CAPABILITY OVER INDIVIDUAL MISSIONS

Those of us who in the past years have urged that adequate attention be given to the prospects of instrumented and manned space flight find themselves now sometimes indirectly accused of utilizing the Russian advances to advocate a reckless plunging into space ventures in all directions without regard of cost to the Nation, military relevance, and the legitimate requirements of other fields.

This argument ignores, or fails to recognize, a fundamental fact in astronautics, which, I believe, is of importance in this hearing, namely, that there are only relatively few but broad energy plateaus as far as the performance requirements for space flight missions are concerned. The energy required is given by the ideal mission velocity which is the sum of all the velocity changes made during a given mission, plus the velocities you lose, while under power. For various missions one adds this all up and then the figures.

Figure 1 illustrates this in a schematic manner. You will notice that widely different distances are covered within the limits of one plateau, depending upon the mission. Each plateau represents conservative values; that is, you probably will need a bit less. Each plateau requires essentially one vehicle type. Therefore, by becoming capable of carrying out a mission which corresponds to a particular plateau, the resulting vehicular capability gives us the option to choose between a considerable variety of alternate missions. For instance, by attaining the capability of flying surface-to-surface from earth to moon, we have at the same time attained the capability of operating in the entire inner solar system. Every expert in the world will know this. We don't have to prove it. The engineers in Russia will know it, and if we do one thing but not the other belonging to the same plateau they will tell Khrushchev we can do it if we want to. Therefore, the emphasis is here on capability. My point is and has been in the past not to advocate that we do all the space missions that can be done, but rather that we concentrate our strength by attaining a given space capability and gradually augment it, as time progresses. The confusing variety of possible space missions becomes more simple and lucid as soon as we begin to think and plan in terms of performance plateaus and their associated capabilities, and, I might add, industrial and other requirements.

This is, of course, not the whole story of space operations, but a fundamental part thereof inasmuch as the development of space vehicle systems is not only very expensive but also very time consuming. Once a competitor is ahead of us in the development of a vehicle signifying a certain capability plateau, it takes time—more

than money—to catch up with him. Another important aspect is that of ground organizations and launching sites. Launching sites for ballistic weapon systems are extremely expensive, because they are needed in large numbers.

The numerical requirements in the case of nonmilitary—and in many cases also of military—space operations are much more modest, because there are not so many appropriately located places to launch space vehicles. In either case, however, their relative cost decreases with the number of launching which they handle. Therefore, if launching sites for space vehicles are selected judiciously, to enable one to reach as many orbits as possible from a given site, it will be feasible to reduce their cost to much lower values than those we have to accept at present for the buildup of a retaliatory ICBM and IRBM force.

A third point in regard to space operations is that, for the various missions attached to one capability plateau, the payload requirements may vary considerably, thereby suggesting offhand the need for different vehicle sizes after all. For example, a manned expedition to Mars and back which lasts hundreds of days requires more basic payload than a manned trip around the moon which lasts only a few days. However, in space flight, variations in payload weight generally affect only the number of vehicles to be launched for the mission, rather than warranting the cost of a new vehicle development.

I have given you by necessity a simplified picture. However, I want to emphasize the fact that, especially in space flight, if we have the vehicle system, representative for a given performance plateau, adequately developed, we have accomplished the biggest part of the job and can begin to utilize the capability which corresponds to this plateau.

SPACE CAPABILITY

Figure 1 distinguishes between six plateaus or steps, representing distinct space capability levels. We have at present reached the first plateau, namely, that of small instrumented satellites in the immediate vicinity of the earth (terrestrial space). Russia has, in effect, already climbed up to the second plateau, beginning with the moon probe capability, although, to my knowledge, they have not yet flown this particular mission. However, that their capability qualifies for the second plateau is evident from the orbit and the payload of Sputnik II. We would be at par with Russia if we could use our ICBM vehicles today for launching space probes into earth satellites and to the moon. The President has authorized ARPA to introduce this year our IRBM vehicles into the space research program. These vehicles can reach the moon with proper addition of stages, but their payload weight is probably smaller than the potential Russian payload for the same mission.

The exploration of the moon is of great scientific importance and of military value due to the insight we will gain into the conditions in cislunar space the observability of the earth's surface from very high altitude. Depending on what we find out about the lunar surface, there may be an element of military interest involved, although at the present time we should regard these experiments as space-scientific in nature, rather than anything else.

Astronomically, the moon experiments are the first to require a more stringent coupling between launching site and capability of reaching the target body. While, for most satellites any launching site will do, this is no longer the case to the same degree for moon flights. For one-way missions it is still possible to fire a probe to the moon along a transfer orbit whose plane is inclined to the plane of the lunar orbit. However, the accuracy requirements become more severe in this case than if the planes of the two orbits were close or would coincide. Russia is so far north that it cannot avoid using a less favorable orbit than the United States.

This fact might have to do with their apparent delay in firing a moon shot. However, I want to emphasize that this is not a compelling reason. For more sophisticated tests requiring the probe to return to earth, conditions become even worse for a country located like Russia. An inclined orbit cannot be used, in this case, unless either the probe remains always at a great distance from the moon (which is scientifically undesirable) or considerably more energy is stored in the vehicle for powered maneuvers. Likewise, the establishment of lunar satellites becomes more expensive—in terms of energy required—when approaching the moon in inclined orbits.

Conditions become really bad for a country like Russia if one considers interplanetery probes (artificial comets). At least if chemical space ships are used, it is necessary that the launching site on this spinning gyro which we call the earth must be located in the belt between the Tropic of Cancer and the Tropic of Capricorn, or much higher energy requirements must be accepted. Russia owns no territory in this belt and therefore must either launch from the southernmost region of China or from northern Indochina or from the deep south of Egypt. However, in each case it would be just south of the Tropic of Cancer; that is, in the northernmost region of this belt.

Now, the farther the launching site is away from the Equator toward the northern or southern border of the belt, the longer becomes the interval between possible launchings; namely, when this launching site crosses the ecliptic plane. Since the launching time is, in addition, fixed by a prescribed relative position of earth and target planet, it follows that two conditions must coincide timewise to permit the launching of an artificial comet. The probability of this to occur becomes the more rare the farther away the launching site is from the Equator, involving waiting times of years or even decades between firings.

Here we have a clear example of the need for international cooperation in interplanetary experiments, if reason can prevail in these matters over hostile pride. Nations in far northern and southern territories preferably rely on nations with equatorial or near equatorial territories for the operation of launching complexes. On the other hand, observatories in the far north or south are valuable tracking stations for artificial comets at certain times. I proposed last year to the International Astronautical Federation in a paper submitted about 4 months before Sputnik I:

> * * * that serious considration be given to the organization of an International Astrophysical Decade for the study of the interplanetary environment of our earth and for the preparation of manned space flight. This operation should follow the International Geophysical Year after an appropriate time

interval and when the necessary technical prerequisites are available, perhaps from 1965 to 1975.

President Eisenhower has repeatedly emphasized this country's desire to join with other nations in the peaceful exploration and utilization of space. When Russia had the sole lead in spacecraft, Mr. Khrushchev proposed a race into space. I believe the Soviets have missed a fine opportunity here of showing that they are willing to utilize new areas of human exploration for cooperation.

I think, now, that we are a spacegoing nation also, we should take a better approach and, through our civilian space agency, when it is established, invite other nations into a cooperative effort in this matter.

The third capability plateau beyond the moon shown in figure 1 involves landing on the moon, the establishment of satellites around Venus and Mars, and probing beyond these two planets into the region close to the sun (solar probe) and into the asteroid belt between Mars and Jupiter.

When the fourth plateau is climbed, man can conduct flights around the moon nonstop from the earth's surface without the aid of assembly and fueling in an intermediate satellite orbit. If starting from a satellite orbit in this plateau, he could land a party on the moon and return. This would be primarily done on the basis of chemical power. We would be principally capable of collecting enough material in an orbit, using chemical ships, to think of a round trip to Mars or to Venus (without landing) by means of chemical spacecraft. However, I do not find this prospect very attractive since it involves very long mission periods (times of absence from earth) with the accompanying psychological problems and the enormous demands on equipment endurance and reliability. This impression is augmented by the awareness that when we are ready to undertake manned interplanetary operations (which is perhaps about 10–15 years from now), we will most likely have nuclear-powered rocket engines at our disposal.

They would (step 5) permit manned flights to the moon from the earth's surface and enable us to conduct fast interplanetary reconnaissance flights to Venus and Mars. For reasons explained above, the advantage of shortening the mission period to a year or less would have a great effect on the crew. Moreover, it seems to me that flights without landing should precede those involving a descent to the planetary suface, in order to gather the necessary information for the preparation of a planetary landing.

VEHICLES AND PROPULSION SYSTEMS

The heart of the missile or space craft is its propulsion system whose power and performance decides the vehicles range and payload capacity. Presently we have two orbital vehicles in the flight stage, the Jupiter-C and the Vanguard. In addition, the American missile arsenal offers IRBM's and ICBM's for a more consequential oribital capability, and a first lunar and interplanetary instrument-carrying capability. This capability is attained by using the booster power of the Thor, the Jupiter, and the Atlas to carry upper stages into space which transfer the required terminal velocity to the payload capsule proper.

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Because of its enormous booster power—the largest under development in this country—the Atlas can logically carry the greatest load into space at the earliest time. With an additional high-energy stage development which altogether represents a smaller additional effort than the effort required for any other missile presently under development, the interplanetary missions mentioned in step 2 (fig. 1) can be carried out with a meaningful payload weight. Without further changes aside from those just mentioned, Atlas could boost a heavier payload weight into space inside the planet Mercury than any of the IRBM's this year will be able to carry around the moon. The simplicity and utmost emphasis on reliability designed into the missile under the leadership of the former chief engineer and now technical director of Convair-Astronautics, Mr. K. J. Bossart, has paid rich dividend in the Atlas firing program. Notwithstanding my unforgettable days with the V-2, I must say that the Atlas flight-test program, up to now, is the most remarkable event in missile development I have witnessed. The Atlas is the first missile to be tested outright with two large engines. Not a single explosion on the test stand has occurred and no principal flaw could be found. The design of the missile is sound and reliable. I am convinced that the Atlas will be ready for the national space program in the very near future without interrupting its primary development.

Among other work Convair has teamed up with Avco in an effort to establish the first steps in manned space flight as soon as possible. If we really have an early augmentation of our national space capability at heart, we will use this vehicle—and we will initiate the before-mentioned steps to increase its performance without delay—until something better is proved out.

I am saying this in order to underline the fact that we are technically not behind Russia. We are only at the moment in our hardware capability not at the same point as Russia.

Mr. McDonough. Was the Atlas designed by a proposal from Air Force to industry to built it, or did industry submit a proposal?

Mr. Ehricke. In this particular case, industry submitted a proposal on the request of the Air Force.

In 1946 the Air Force requested a number of companies to make proposals for long-range guided missiles. These missiles can be flown ballistically or, like the Snark, with an air-breathing engine or ramjet engine.

At Convair at that time the opinion was that the ICBM was on the long run, the best solution, although the toughest to begin with.

The proposal on which the Atlas design was based has come from the engineering department of Convair as such.

Mr. Ford. Are you inferring, sir, that the Atlas powerplant puts us in the same area of capability with the Soviet Union at the present time?

Mr. Ehricke. Not at the present time, because we cannot launch the Atlas with full payload yet, we are still in the test phase, but once this is done we are at par with them so far as plateau of capability is concerned.

The Chairman. How close are we to that?

Mr. Ehricke. As far as technical capability is concerned, we are one to one and a half years behind.

This is as far as space flight is concerned. The weapons system team requires more. It requires that we set up a system of logistics and supply and train troops.

Mr. McDONOUGH. How about test flight?

Mr. EHRICKE. Test flightwise, at the present time, I think we are still behind, because the Russians have launched the ICBM over the full range of 4,000 to 5,000 miles. We have not done this.

The CHAIRMAN. In other words, your testimony is that they have at least a year and a half advantage on us?

Mr. EHRICKE. I would believe they have at least a year and a half advantage.

The CHAIRMAN. Suppose they perfect the intercontinental ballistic missile where it can hit the target. They have the propulsion power now?

Mr. EHRICKE. Yes.

The CHAIRMAN. Whether it has been perfected, is the big question, is it not?

Mr. EHRICKE. Yes, but it is not the whole question.

You see, one must make a difference between the state where the missile is technically capable of doing its job and the state where the nation's defense is equipped to such an extent with the necessary organization, the setup of the bases and so on, that this particular missile represents a retaliatory or deterrent power.

Now, I do not think that the Russians have reached that stage yet with the ICBM, but neither have we and we are behind them in this respect.

The CHAIRMAN. They are a year and a half ahead of us at the present time. The production difficulties are easier to overcome than the propulsion difficulties, are they not?

Mr. EHRICKE. Yes, in general, development requires more time than production.

The CHAIRMAN. The thought enters my mind that if they perfect the ICBM before we do, and they perfect the defense against our intercontinental bombers, SAC, where do we stand?

We talk about all these formulas with Mr. Fulton. I would like a formula of my own.

Mr. FULTON. I would like to answer your question on that one.

The CHAIRMAN. I would like to get the information from anybody. That is the key to my mind at the present time.

Mr. EHRICKE. I believe, in the time between now and the time we have perfected the missile as a deterrent power, it will be very difficult, if not impossible, for them to perfect their defense against our bomber force to such an extent that our bomber force ceases to be a deterrent means.

The CHAIRMAN. I am glad to hear that.

In other words, it is not necessary or our bombers to go actually over the target.

Mr. EHRICKE. It is not necessary that they do that. We can employ other tricks.

I think at the present time we have to rely on our bomber force as a main deterrent still for a number of years. This has nothing to do with the space capability primarily. I think these two things should be set apart.

The CHAIRMAN. Is it your opinion that we will retain a retaliatory power?

Mr. EHRICKE. Yes, sir. We have it, and we will retain it. I don't think the Russians can take that away from us.

The CHAIRMAN. In the present world of today about the only level you can deal with them is under the law of self-preservation.

Mr. EHRICKE. That is true.

The CHAIRMAN. If they ever get a decided advantage over us, why, it presents very serious thought.

Mr. EHRICKE. Yes. I think this is one of the reasons why we have to go out into outer space. It is true, there are millions of things we can do on the earth, but being a leading Nation and being responsible for the defense of a way of living on a large portion of the globe, we must go as far out as anybody else does and we must be able to meet fire with fire wherever it occurs.

There is no doubt that at least the immediate vicinity of space can be made useful in a military way. We have no idea yet firmly whether the moon or the planets will ever be, I don't know.

But certainly satellites and chemisphere and ionosphere vehicles can be made useful. We have to convince ourselves in which way they can be made useful.

We have to develop the necessary technology.

Beyond that we have to go further out and find out whether anything else could possibly threaten us or not.

For instance, with respect to lunar bases my opinion is that we really do not know yet whether a lunar base will be useful or not, but we cannot afford not to find out.

The CHAIRMAN. One thing that has occurred to me during these hearings is that I am glad we have dedicated men like you before us giving us your opinion and contributing your God-given talents for mankind, our country and our way of life.

Mr. EHRICKE. Thank you.

Mr. O'BRIEN. Do I understand that you feel that SAC has really purchased for us the most valuable 18 months in our whole history? In other words, those 18 months are mighty important and they are the holding force.

Mr. EHRICKE. I am firmly convinced. They are shields behind which we have to build up the other things.

Mr. O'BRIEN. Assuming we move along with all possible speed in the other field?

Mr. EHRICKE. Yes.

Mr. FORD. Does the Atlas missile give us the ability to get a payload like Sputnik 2 into orbit?

Mr. EHRICKE. I would say yes, definitely it gives us this capability. The Atlas itself will act as a booster. You can attach small upper stages to it.

If you take existing upper stages it can already carry at least as much into an orbit as Sputnik 2 did.

If we develop a small high energy upper stage, which weighs something like 20,000 to 30,000 pounds, then we will be able to carry some 6,000 to 8,000 pounds into an orbit, which is vastly more than Sputnik 2 has done so far.

Mr. O'BRIEN. In that subsequent development, are you talking of something within a year or two, or does it coincide with the Atlas development?

Mr. EHRICKE. It does not coincide fully with the Atlas development; depending on the permission we get to go ahead with the full development it will take two or two and a half years before we will be able to launch this payload of very high capability.

I do not know whether the time permits this, Mr. Chairman, but I have a model with me which shows one particular capability of Atlas which I think is one of the primary means by which we can leap-frog possibly the Russian development.

If I may say this, there are two things which are particularly important for the establishment of an adequate space capability in my opinion. That is to get man out into space, to be able to run man controlled ships in space, and No. 2, the adequate development of a nuclear propulsion system.

If I may, I can shorten my statement a little bit and just read my primary recommendations.

Mr. NATCHER. That will be all right. You proceed as you wish.

The CHAIRMAN. Your whole statement will be put in the record. You use your own judgment.

Mr. NATCHER. You can either complete your statement, Mr. Ehricke, or put the rest of it in the record.

After the questions we would like to examine the model and have you explain it to us.

Mr. FULTON. Before we leave Mr. McCormack's question on that same point, the question comes upon the strategic use of a weapon like Atlas.

The United States, I believe, has based its security on the fact that there is no particular system on weaponry on which we place our entire reliance. Therefore, I do not put the security of the United States or the superiority of Russia, or any possible enemy, in any one class of weaponry.

As a matter of fact, unless the ICBM is supplemented by intermediate range guided ballistic missiles, the system is not complete.

Mr. EHRICKE. I agree with that.

Mr. FULTON. The time between the B-52s in the SAC Air Force and the blank in time and distance in reaching the ICBM program is to be filled by the intermediate range missile.

In the intermediate range, between the 900 and 1,500 mile range, we can bring under accurate attack between 65 and 70 percent of the industrial territories of the military installations of both China and Russia.

Under those circumstances, if we would depend on the ICBM long-range missile alone, we would be the equivalent of doing the big Bertha operation against Paris in World War I.

In the first place, it costs too much to develop that type of missile for shorter ranges.

Secondly, on the trajectory it can easily be traced.

Third, when there is a long trajectory there is more chance of interception or diversion by a nuclear shot or some other way that has not been disclosed.

Next, it is an expensive payload because it is a concentrated payload with a small dispersal range.

On the other hand, when we have the short range guided missiles, we can fire them at a predetermined point with little instrumentation and litle chance of diversion and they would arrive much more quickly than the ICBM would. So there would be very little chance of interception.

Likewise, where we might have one ICBM, we could have a broadside of 100 intermediate range guided missiles, or ballistic missiles.

So I don't feel that we should be too concerned about the fact that we are taking the time to come up with a good ICBM program and go about it in the right way when have other available means, in the Air Force, Army, Navy, and submarines, that can protect the United States and the free world. Would you agree with that?

Mr. EHRICKE. Yes, sir; I agree with that statement.

Certainly we should not rely on one weapon system alone. I was bringing the ICBM out as an example.

In my opinion one of the most important allied weapons system presently under development is the Navy Polaris concept. This whole concept is strategically very masterful and I think it is one of the best and we will have to rely very much on this one. The air-launched missile is another important approach.

As far as the IRBMs are concerned, there is, of course, this one point: that in order to reach so many targets you have to rely on overseas bases. This is one point that some people are objecting to; they want to have the capability of striking back from the United States.

Mr. FULTON. Let me answer that argument by the statement that the ICBMs operate from immovable base while the IRBMs are on movable ones and they do not particularly have to be on land.

Mr. EHRICKE. Yes. However, I would like to say there is nothing that prevents us in future developments from putting the ICBMs also on movable bases. That is entirely possible.

Mr. McDONOUGH. In your experience with the V–2, you had a large number of failures before you finally developed it?

Mr. EHRICKE. Yes.

Mr. McDONOUGH. In its ultimate stages in perfection was it any more accurate insofar as hitting the target is concerned than our IRBMs are today.

Mr. EHRICKE. I don't think it was more accurate because the final guidance system was not developed for it. It was too late. It operated with an intermediate capability kind of guidance system.

If the final guidance system had been developed it probably would have been at least as accurate as the present IRBMs, but as it was, it was not.

Mr. McDONOUGH. You were shooting a distance less than 1,000 miles?

Mr. EHRICKE. Yes, about 200 miles.

Mr. McDONOUGH. In the IRBM program we have in this country, and the number of IRBMs we have, you can hit the target easier at a short distance than you can at a long distance?

Mr. EHRICKE. Yes.

Mr. McDONOUGH. With the ICBM that Russia may attempt to shoot here, if they ever do, from their continent to our continent,

there would be a greater possibility of error in not hitting the target?

Mr. EHRICKE. Yes. That goes for ours too, incidentally. There are ways of improving this, sir, but they would be advanced techniques. You see, at the present time we are trying to perfect the weapon system to a point where we can do something with it.

In the years thereafter, it will be possible to perfect it further as to increase of accuracy, to reduce its vulnerability, also reduce its size.

There are various things that one can do.

Mr. McDONOUGH. Do we know anything about how many ICBM's they have and how long it takes to produce one?

Mr. EHRICKE. Sir, I cannot answer that because I don't have the information about the Russian's capability.

Mr. McDONOUGH. How long does it take us to produce it?

Mr. EHRICKE. I don't know whether that is an unclassified question that I can answer here at the moment.

Mr. FULTON. The defect with the ICBM is that when it passes through the atmosphere on its initial trajectory and when it reenters it has a longer trajectory in the jet airstream above the earth than a lower type intermediate missile, does it not?

Mr. EHRICKE. There is a small difference, sir, which is, however, not significant on the orbit particularly because it passes in both cases so fast.

Mr. FULTON. It would not have any effect?

Mr. EHRICKE. No, sir; it would not have any effect. The effect that wind streams have—and you have a correct point here, however, it is not connected with the jet stream; it is connected with gusts in the atmosphere—is that you have a nose very blunt, then it is being slowed down more quickly than a sharp nose, and as it is being slowed down more quickly it is more subject to slight deflections from gusts.

This goes for both IRBM and ICBM noses.

If you wish to eliminate it for both, you must go to sharper noses.

Mr. FULTON. That nose, when it is extended to quite a surface, has a sail technique, does it not?

Mr. EHRICKE. In a sense, yes.

Mr. NATCHER. Mr. Ehricke, you may proceed with your statement, or you may insert the balance in the record and hold yourself open for questions; anything you desire.

Mr. EHRICKE. Yes, sir.

However, the thrust power of the Atlas and Titan ICBM's presently under development is limited to a few hundred thousand pounds. In conducting operational and technical studies of orbital systems several years back it became clear to me that for space flight we would need vehicles of bigger size and higher thrust power, although not quite as high as some figures presented at that time.

Four years ago, in 1954, I presented a paper to the American Rocket Society and another paper to the International Astronautical Federation in which I described and recommended a 3-stage system of about 1.7 million pound booster thrust for the establishment of consequential manned satellite systems. These vehicles were designed in 2 modifications, 1 looking like a ballistic missile for cargo supply, the other for personnel transport, carrying a lift-drag reentry system to assure return of the crew. The thrust of the second stage turned out to be 346,000 pounds, a value which resembles somewhat that of our present

ICBM's with which I was not familiar at the time. It was almost hopeless in the past years to arouse interest in a booster of such thrust power, because progress in nuclear bomb development and improvement of on-board electronic equipment indicated a trend toward lower weights, thereby suggesting that the trend in future ballistic missiles would be toward smaller rather than larger boosters. I am very glad to see increasing emphasis placed on the development of a large booster engine prototype of 1 to 1.5 million pound thrust.

My recommendation from the earlier paper is unchanged and in terms of present missiles suggests that we concentrate on the development of a booster for the present ICBM's, preferably winged and recoverable, as a next step. It is true, we most likely will not require such a booster for future ballistic missiles, but it will a few years from now be regarded as indispensable for our scientific as well as defense capability in space. A 1.5 million pound booster carrying an ICBM vehicle allows man to circumnavigate the moon starting from the earth's surface and returing into an earth satellite orbit. Whether or not the need for still larger chemical engines will exist depends primarily on our nuclear propulsion systems development program. Having the 1.5 million pound motor available, we can cluster, say, two of them and use the resulting booster for transporting a nuclear upper stage beyond the denser atmosphere where the reactor can be started at moderate shielding weight requirements for the crew, because of the absence of radiation scattering produced by air molecules. I am talking here about a nuclear heating system using, for example, hydrogen as working fluid. Such a system would have enough thrust not only to accelerate the vehicle in space, but also to decelerate or accelerate it at the moon's surface, in which case the thrust must be between 16 and 20 percent of the vehicle's weight (0.16 to 0.20 g). By changing from chemical to nuclear propulsion or the upper stage at this point of the development, we jump toward a vastly more powerful system, exceeding by far any conceivable improvement resulting from further enlarging the chemical system alone. The importance of such a system lies primarily in the fact that it enables us to establish a base on the moon, if we so desire, and to supply it with a sizeable payload, about 25,000 pounds in nonstop earth-to-moon flights without intermediate fueling. Alternately, the system provides us with the capability of conducting fast reconnaissance missions to Venus and Mars, or getting one-way heavy loads, something like 30,000 pounds nonstop from the Earth to Mars. It therefore covers actually both capability plateaus 4 and 5, in figure 1.

I would like to mention one additional level which is in the more distant future. It involves the use of very low thrust propulsion systems in orbit-to-orbit (i. e., not surfacing) spacecraft. Namely, the ion system, or the plasma system, or the photon system, and I mean the actual propulsion by light pressure, not the reflection of light, not the light sail, but the photons system that produces light and propels it out. The exhaust velocity of these propulsion systems exceeds even that of the nuclear heating system by at least a factor of 10. Thereby the vehicle can carry enormous payload weights to another planet, but due to its slowness the travel time is again very long.

Primary useful for interplanetary flights are not the photon rockets, but the ion or plasma system, but they have very low thrust-to-weight ratio.

Now, you cannot fly fast from one planet to another, you fly very slowly. It takes many days, 400 days with ion, while it takes 120 days for a nuclear ship.

Consequently, for people where you want to get across space fast for various reasons, you probably prefer the fast transportation, but if you push heavy loads, these low-thrust systems will be very good.

By combining these slow heavy-payload freighters, which could be sent ahead, with the fast nuclear passenger vehicles, mentioned before, we will attain the capability of carrying the equipment required to explore the surface of our neighboring worlds Mars and perhaps Venus, and we can land; that is, not only circumnavigate them, but go down the surface.

In conclusion I would like to summarize my main points:

1. A comprehensive, consistently supported and vigorously executed national space flight program is urgently needed. Not until we have such a program will we be able to bend the curve of our rate of progress upward to the extent required to at least match the Russian rate of progress in this field.

2. I feel that President Eisenhower's recommendation regarding the National Aeronautic and Space Agency is a very good one and should be fully supported. I have two comments in this respect: (*a*) I hope that, in implementing the President's proposal, the Director of NASA will be kept out of politics as much as possible and will be given adequate power of decision as well as the right to make commitments exceeding 1 fiscal year. (*b*) The number of people in the proposed Board of Directors is quite high (17). Perhaps thought should be given to reduce it somewhat.

I would like to add another comment to it and that is that I hope this agency is cooperating to the maximum extent with Government research and development institutes, such as the Air Force at Cambridge and Redstone Arsenal and so on, the Navy facilities, as well as industry, rather than trying to duplicate things, above all, military developments.

I think this country has a most amazing stock of responsible industrial and Government-owned development agencies that any country has in this world and we should utilize them.

If we utilize this capacity to the fullest in good cooperation with other Government agencies, especially the Department of Defense, and their facilities, I think we cannot be beaten.

3. In our space flight planning we should adopt the principle of plateaus of accomplishments or levels of capability to bring the confusing variety of possible missions into perspective and avoid diffusing our efforts.

4. We need now lunar and interplanetary space research and early development of a manned space capability. This can be accomplished by using hardware presently under development to attain maximum reliability and countdown precision at the earliest time. We are doing part of it; we are putting the IRBM's into the game right now, the Jupiter and the Thor, and one way in which we can put the Atlas in I want to point out later with the model.

5. We need vigorous engineering work toward the development of a 1.5 million-pound chemical rocket engine and smaller high-energy propellent engines for high-performance upper stages. These are

strictly engineering jobs; you don't need a Nobel Prize winner to do the job. Just take our good engineers and they can do if they are allowed to go ahead.

6. We need concentrated technical and scientific efforts to have available a nuclear heated engine when we presumably may want it, which may be as early as the second half of the next decade. That is the next plateau and we must not let anybody else outjump us in this particular field because that is more dangerous than Sputnik. Nuclear energy will mean for astronautics what the combustion engine meant for the development of aeronautics.

7. We must encourage new basic and applied research in the field of energy concentration and energy conversion techniques. Then, as the result of a deliberate rather than a crash program, based on farsight rather than a craving for immediate utility, we will 10 to 15 years from now have spacecraft propulsion systems second to none.

Thank you, Mr. Chairman, for permitting me to make this statement.

Mr. NATCHER. Mr. Chairman.

The CHAIRMAN. I have no questions to ask except to say that in reading the prepared statement, sir, it is very illuminating and complete and your extemporaneous answers to the questions were very clarifying.

Mr. NATCHER. Mr. O'Brien.

Mr. O'BRIEN. Mr. Chairman, like Chairman McCormack, I think Mr. Ehricke has done a magnificent job. I was very much encouraged by your statement that if we utilize what we have we can really go places.

Do you think that we can best do that by creating, perhaps in addition to this space agency, a Secretary of Science in the President's Cabinet who could reach all those fields and who could cooperate perhaps more closely with the Atomic Energy Commission and bring all these forces into play?

Mr. EHRICKE. I think this is a good thought, sir. I do not know exactly in what way NASA would work with AEC, but somehow it is necessary for our national space capability that these two agencies work very, very closely.

Because the heart of space flight is propulsion, all of our present difficulties in navigation, accuracy requirement, stem from the fact that we don't have enough energy.

If you have energy to make corrections, you can make a mistake and it does not matter.

The better we are in the field of propulsion, the greater will be our capability.

So we must not only have wisdom in selecting the missions; we must recognize we have to get a nuclear propulsion system as soon as possible for upper stages at least.

Mr. O'BRIEN. You think the Director of the proposed agency should be as free as possible from a political atmosphere?

Mr. EHRICKE. Yes, sir. I mean this in the sense that he should be somewhat shielded by the board in ironing out the basic line of policy and interest, I mean to weigh it and balance it to other necessary national requirements.

But when he has a line, let him go ahead and do his job and do not ask him to take too many things into consideration which should be handled at the board level, not his level.

Mr. O'BRIEN. Perhaps he should be appointed for a longer term than most public officials are appointed.

Mr. EHRICKE. I think this is true because this is a technical job more than anything else, the way I see it.

Mr. O'BRIEN. It is just as important to give him continuity as it might be for a judge, for example?

Mr. EHRICKE. Yes, sir.

Mr. O'BRIEN. Thank you very much.

Mr. NATCHER. Mr. McDonough.

Mr. McDONOUGH. No questions.

I appreciate your statement very much, sir. You have given us a very practical view of the whole thing. Knowing a little of your background and the experience you have had and the fine things you have done since you have come to this country, I feel the committee is very fortunate in having you as a witness.

We appreciate the fact that we have the use of your talents in this country.

Mr. EHRICKE. I am happy to make them available to you, sir.

Mr. NATCHER. Mr. Fulton.

Mr. FULTON. The question comes up at what stages we should develop our increased thrust engines. There have been proposals here for starting off with a third of a million-pound-thrust engine and then likewise carrying on a program for a million-pound-thrust engine.

What is your approach? Would you start with a million and a half pound thrust engine, would you try it by intermediate stages, or do you think it is necessary we build up to a million and a half pound thrust engine?

Mr. EHRICKE. I believe I would like to give my answer in two phases. If we develop a 1- to 1½-million-pound-thrust engine right now, we are making a fairly big jump, although not as big a jump as from the preliminary engine to V–2 engine.

However, on the jump to the million pound engine we are going to a large combustion chamber. We do not fully understand the problem of vibration and exitation of gas layers in large engines.

We do not understand resonance conditions in such large engines.

Therefore, I believe it is desirable to carry a 300- to 400-pound thrust engine at least up to the point where we can test fire it and see whether there are any particular changes.

We can study this engine from a technical point of view while we are going ahead and doing the breadboard design for the one million pound stage.

Mr. FULTON. We could do that in 2 years while a million would take 5 to 10 years and, if that is an estimate, how long would the million and a half pound thrust engine take?

It would be some tremendously long time, would it not?

Mr. EHRICKE. No, sir; the million and a half takes about 5 years and the 300,000 to 400,000, to be available, takes about 4 years. There is approximately a difference only of about one to one and a half years.

The one and a half million pound engine can be easily throttled to be one million without loss. It would be one and the same engine actually.

Mr. FULTON. You would rather proceed on one large engine than try to have clusters of combinations of smaller engines?

Mr. EHRICKE. Yes, sir. I think if we do it we should primarily concentrate on the one to one and a half million and keep the 300,000 pound engine as a test engine and as a technical development system.

If the need arises before we have the 1½ million we can still throw it into the missile system, but I think by doing both we are delaying the big engine.

I am not sure that that is very desirable.

Mr. FULTON. We are always trying to get the definitions here because people in various parts of the country use the words with different meanings.

For example, photon means to us just the energy or velocity of light used as a propellant rather than what we would call solar power with the sail effect.

Mr. EHRICKE. Yes, sir; the photon system in its original definition is a propulsion system in which you convert. According to Einstein's equation $E=mc^2$, you convert matter into energy. You can do this far away from the sun.

That is the photon rocket.

The other one would be the light reflecting, the sort of sail type.

Mr. FULTON. And we would need approximately 50 million square feet of sail?

Mr. EHRICKE. Very large in any case. I am not sure that this would not be too big to be practical.

Mr. FULTON. Do you think the problems of mass are too much for the ion engine programs and the photon propellent programs to solve? Should we go ahead with those two programs, or are they not practical simply because of the low rate of thrust compared to the mass involved?

Mr. EHRICKE. Sir, the ion ship is definitely practical. It has between 5×10^{-5} and 10^{-4} acceleration.

This is perfectly practical. I believe 20 years or so from now we will have freight ships going, pushing heavy payloads across the solar system using this system.

The photon rocket however, as we can see at the present time, probably will not have more than 10^{-6}.

In order to illustrate what this means, let me say the following:

The photon rocket, as often quoted by Dr. Saenger in Germany, has been quite popularized as a means for travel from one stellar system to another, from one galaxy system to another, but for one thing: If you have an acceleration of 1 G, then you reach 80 percent of light velocity after 1 year's acceleration and you have realistic effects.

The time for you passed slower. If you have, however, the photon rocket, with 10^{-6}, it takes you 1 million years to reach that condition in the first place.

In order to utilize it, you have to have generations living and dying for a million years and then you have reached the stage where your descendants really have begun to age less than the others. This is the disadvantage as we see it right now.

Unless you can change that, the photon rocket will be no good because you won't outlive the rocket.

Mr. FULTON. You look for the chance, then, that the human generations will age less if these projects were carried on to the point where we got into velocities we were speaking about previously, just under the speed of light?

Mr. EHRICKE. Yes, then they would age less.

I would like to bring up one other point. We are always looking at this from the viewpoint of propulsion, but there is another much more difficult and dangerous effect involved here.

If we have the propulsion power to push something to limit of where we get relativistic effect, where you get 90 percent light velocities, or so, then you experience something that is roughly analogous or equivalent to the aerodynamic heating problem, because now when you move almost a billion feet per second, and you have, maybe, a half square mile in area of your overall system, then you are sweeping space at the rate of about 90,000 cubic miles per second.

Now, although space theoretically is empty, it is not really empty and you are hitting an awful lot of dust and corpuscles and this cosmic debris has nearly light velocity with respect to you.

In other words, they are, with respect to you, like cosmic radiation and even if you exceed half the velocity of light, the intensity of your apparent cosmic radiation due to this friction problem and heating problem goes up so tremendously that your ship after you arrive somewhere else is probably so radioactive that you don't get out of it any more.

That is the point. You have a sort of nuclear heating and you will probably need protective spheres of 10's to 100's of miles in diameter filled with hydrogen, to protect you from this cosmic debris that runs into you and makes your whole ship radioactive in no time.

That is an even tougher problem to solve really than the propulsion system.

Mr. FULTON. Have you any idea that the problem of weightlessness can be solved by magnetic means? Can we use magnetic systems to solve that problem?

Mr. EHRICKE. We could, sir. There is one disadvantage. The magnetic field energy, the magnetic attraction decreases with the cube of distance.

If you are at any particular attracting point, if you double your distance, then your attractive power goes down to one-eighth, 2 by 2 by 2.

That means you have an enormous gradient in attractive power and that may confuse your organisms very much.

I know some space medical people do not recommend this for that particular reason. It may be better if we just rotate slowly to get artificial centrifugal gravity.

Mr. FULTON. If we are out from the earth about 25,000 miles and consider ourselves in one of these ion propelled vehicles also, then if we have 75 tons that we are speaking of, which would be 150,000 pounds, actually if that is placed in the atmosphere, it would only weigh a pound or two as we would know it on the earth's surface?

Mr. EHRICKE. Yes, far out in space its weight would be reduced.

Mr. FULTON. But the question would be then, do you feel that the mass of the vehicle would prevent us from using these lower energy

systems where the thrust might be 10 pounds of thrust, for example, to about 2 or 3 pounds of weight of the vehicle? Do you think that would prevent us from using those low accelerating type systems?

Mr. EHRICKE. Sir, if I understand your question right, you suspect that the system may accelerate faster possibly if it is further out than it is near the earth?

Mr. FULTON. No, I am saying where there is very little weight clear out beyond the earth's atmosphere, then does the problem of mass, itself, regardless of weight, make impractical a system like an ion engine because it is so low in thrust, maybe a 10-pound thrust?

Mr. EHRICKE. Sir, the mass of the vehicle would prevent the conditions that far out from being significantly better than near the earth. You see, if you are in a satellite orbit falling freely about the earth, say 300 miles altitude, then you are weightless because you are falling freely.

If you apply a very small thrust force, like an ion thrust force, you begin gradually to spiral out.

Now, your thrust to weight ratio essentially remains unchanged throughout the flight unless you are using up very much fuel; but assuming you have a high specific impulse, you don't use much mass to expell.

Then your thrust to weight ratio is the same.

In this question, divide the amount of weight that you expell by one G to get the mass consumption and multiply this value by the exhaust velocity to get the thrust. Furthermore, divide the weight of the ship by G to get its mass. Then define the acceleration in amount of thrust, divided by the mass of the vehicle, and you get the acceleration in feet per second squared and not in Gs. You will then see it makes no difference in acceleration whether you are 300 miles near the earth or 20,000 miles.

The mass of the ship is the same and therefore you don't push much faster out there or actually at all.

Mr. FULTON. I am interested in hearing you say that because you have disagreed with 1 or 2 of the previous witnesses.

Will you describe for the record, or define for us, the arc plasma system of propulsion?

Mr. EHRICKE. Yes.

This is a method of concentrating a large amount of energy in a body of gas. At the present time, you use oxygen and fuel and heat the gas up to a certain degree.

Now, this goes only so far because there is only so much energy chemically stored in the fuel. If you want to do better you can, for instance, take an electric arc and now expand this arc between two electrodes and blow a gas through. Then the tremendous energy concentration from that arc goes into this gas and more energy is being stored in the gas than by combustion. You are producing extremely hot gas.

For instance, if you have hydrogen you disassociate the hydrogen and you partly ionize it. The hydrogen becomes electrically conductive and you have a plasma. Then the gas is ejected.

Mr. FULTON. Is there any reason to believe it is better to go to, for example, Mars, leaving at sunrise and Venus at sunset, or does it not make any difference on the time of Earth's revolution when you leave the atmosphere of the earth?

Mr. EHRICKE. It does not make any difference when you leave the atmosphere of the earth, as long as you are in the correct orbital plane.

However, the time does make a difference for the relative constellation of Mars and Earth. This must be right. There is only a specific time when you can launch, but this time could be morning, night, noon, anything you want.

Mr. FULTON. This is my last point. I have been a Navy Reserve lieutenant and the Navy gave a problem for promotion points that was very simple. They said, "On a plane or missile or vehicle, in space, if the thrust equals the drag and the lift equals the gravity, what is it doing?"

Mr. EHRICKE. If velocity equals drag and lift equals gravity——

Mr. FULTON. What is the plane or missile doing?

Mr. EHRICKE. It is what we call in a condition of stationary flight.

Mr. FULTON. Stationary flight or level flight?

Mr. EHRICKE. Level flight. It goes horizontally or it could climb also, but then its velocity would have to vary according to the variation of the drag.

Mr. FULTON. But it has to be in level constant flight.

Mr. EHRICKE. You would have to say it would be in level constant flight.

Mr. McDONOUGH. You say if the thrust equals the drag and the lift equals the gravity.

Mr. EHRICKE. That is right.

Mr. McDONOUGH. They are both equal?

Mr. EHRICKE. Yes.

Mr. McDONOUGH. That is inertia, is it not?

Mr. EHRICKE. If you lay out a ramjet, then you lay out a thrust for horizontal cruising flight, so that its thrust equals its drag because it maintains whatever velocity it has at that point. You have to accelerate up to a certain velocity, of course, first. Then you keep on going in a constant speed level flight, overcoming with a certain amount of thrust just exactly the amount of drag.

That is the way I understood your question.

Mr. FULTON. Is the plane at the point of stall in the climb at that position?

Mr. EHRICKE. Not necessarily. It depends on the direction of your thrust, sir.

Mr. FULTON. I want to compliment you. You are the only scientist that has answered it so far.

Mr. NATCHER. Mr. Ford?

Mr. FORD. Mr. Chairman, I think this is a very excellent presentation.

I notice at the end of the prepared text there was a biography of Mr. Ehricke. It seems to me this should be included as part of the record.

Mr. NATCHER. Without objection, it is so ordered.

(Information referred to follows:)

BIOGRAPHY OF KRAFFT A. EHRICKE

Mr. Krafft A. Ehricke is assistant to the technical director of Convair-Astronautics, a division of General Dynamics, San Diego, Calif.

He was born March 24, 1917, in Berlin, Germany. He studied aeronautical engineering at the Technical University of Berlin and received his degree as aeronautical engineer in spring 1942. He took graduate courses in atomic physics and celestial mechanics at the University of Berlin.

Beginning in 1930, he visited frequently the amateur rocket launching site in Berlin-Reinickendorf connected with the German Rocket Society and experimented with solid propellent and carbon dioxide rockets. Because private experimental work was discouraged after 1933 he concentrated on theoretical work and model configuration studies. He received a patent on a multistage rocket and propellent feed system in 1936. Subsequently he helped establish the German Society for Space Research for which he wrote a number of technical papers on rocket propulsion systems and space-flight problems.

Periods of study alternated with military service during World War II. In June 1942 he was transferred to the Peenemuende Rocket Center and participated in the development of the V-2 rocket as well as carried out advanced propulsion systems studies. Following the termination of World War II he wrote various technical papers for the American occupation authorities (FIAT) and in 1946 was contracted to join the Department of the Army as jet propulsion research engineer He worked in Fort Bliss, Tex , on ramjets and advanced rocket vehicle system studies until, in 1950, he was transferred to the Redstone Arsenal, Huntsville, Ala., where he became chief of the Gasdynamics Section.

From 1952 to 1954, he worked in the preliminary design department of Bell Aircraft on hypersonic rocket glider projects and, in fall 1954, joined Convair as design specialist on the Atlas ICBM project. When the new astronautics division of Convair was formed, he became chief of preliminary design and system analysis. He was transferred to his present position in April 1957, and heads a small group of senior engineers to concentrate entirely on advanced studies in astronautics

He is affiliated with most western rocket and space flight societies, and has published numerous papers in various countries on astronautics and space research. He is a member of the NACA Aircraft Performances Committee. Among other awards, he is recipient of the first Guenther Loeser medal of the International Astronautical Federation for the best paper presented at the sixth International Astronautical Congress in Copenhagen, 1955, and received the astronautics award of the American Rocket Society in December 1957. He is lecturer for space-flight mechanics at the San Diego State College, and presently completes a two-volume textbook on space flight for the Van Nostrand Publishing Co He became an American citizen in San Diego in October 1955.

Mr. NATCHER. Now, Mr. Ehricke, as I understand, you have a model in the next room. With your permission, we will have it brought in, and we would like to have you explain it to us.

Mr. EHRICKE. Yes, sir.

(Off the record.)

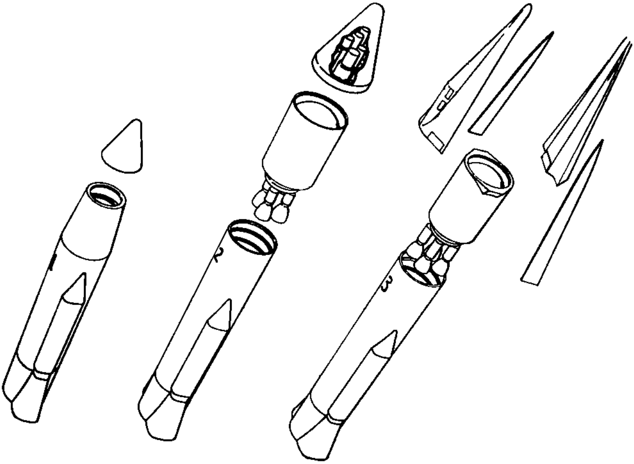
Mr. NATCHER. Mr. Ehricke, you have before us a beautiful model. We would like to have you explain the model to the committee. In making this explanation, Mr. Ehricke, keep in mind we want to get it in the record, so go into detail as much as you desire.

If any of you ladies and gentlemen sitting back in the audience want to move around and get to the side where you can see this better, we will be delighted to have you.

Mr. FULTON. Could we have Mr. Ehricke submit diagrams of the model, to be put in along with his testimony?

Mr. NATCHER. Without objection, it is so ordered.

(The diagrams follow:)



THREE ATLASES

The Atlas orbital system, a permanent manned space station proposed by Convair (Astronautics) division of General Dynamics Corp. requires three vehicles, all based on the Atlas intercontinental ballistic missile. From left, in this exploded drawing, the Atlas itself (1), which would be stripped of its weapons equipment and launched into a 400-mile orbit to become the shell of the space station; the cargo vehicle (2); and the personnel vehicle (3). Both of these latter vehicles would employ the Atlas as a booster, plus a standard second-stage rocket. The cargo vehicle would be able to carry 8,000 pounds of equipment into the space-station orbit. The personnel vehicle would mount two 2-man gliders at its tip. Near the space station, these two gliders would leave the second-stage rocket and dock at the station under power of small steering rockets. The gliders would also be used to return to the earth's surface. The station could be established within 5 years, according to its designer, Krafft Ehricke, assistant to the technical director at Convair-Astronautics, San Diego, Calif.

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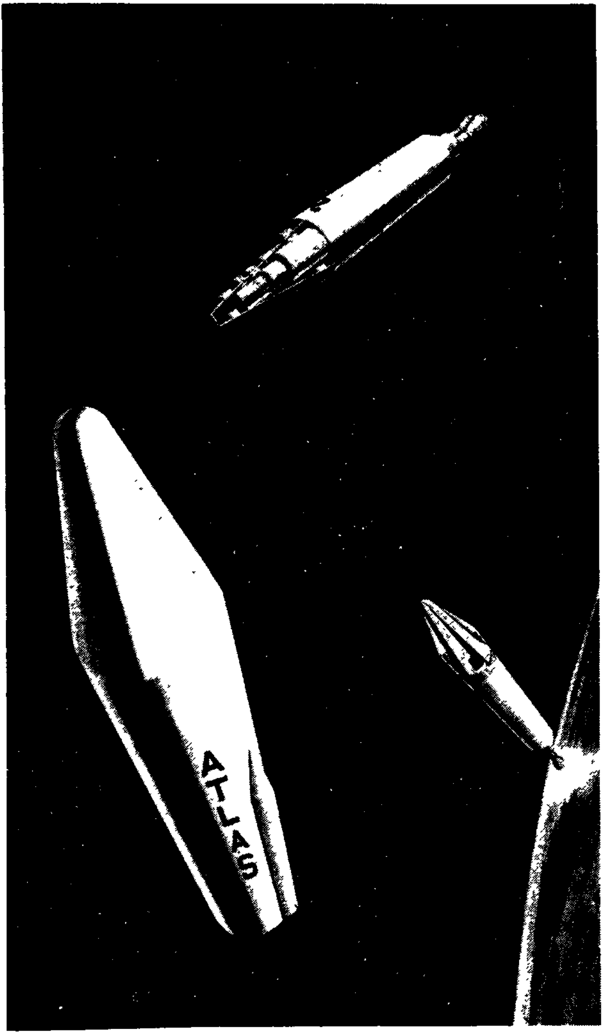
SPACE HOUSE

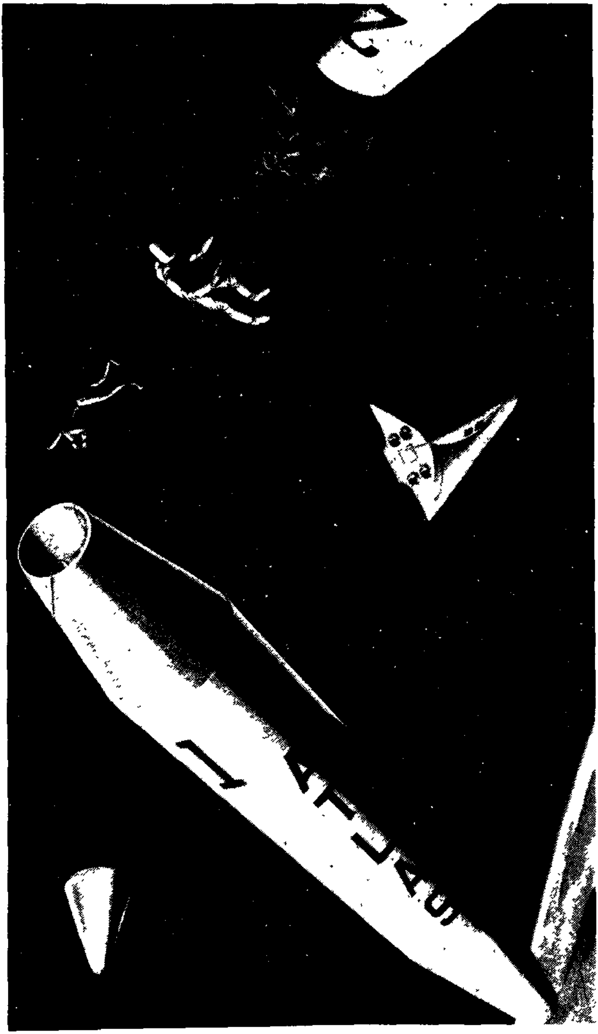
The crew of the Atlas orbital system, proposed 4-man space station, would live and work in the forward tankage of an Atlas intercontinental ballistic missile launched into a 400-mile orbit to become the station's primary structure. The four-level crew quarters, as envisioned by Krafft Ehricke, assistant to the technical director of Convair (Astronautics) division of General Dynamics Corp., would provide for (from left) washroom, eating and recreation room, sleeping facilities, and control and instrumentation room. Rotating the station would give the crew an acceptable artificial gravity. Transporting men and equipment to the station would be accomplished by the Atlas booster plus a second-stage rocket, developed as part of the system. Descent from the space station would be by two-man glider.


ATLAS

[First of series of three photos]

ATLAS SPACE-STATION BUILDUP

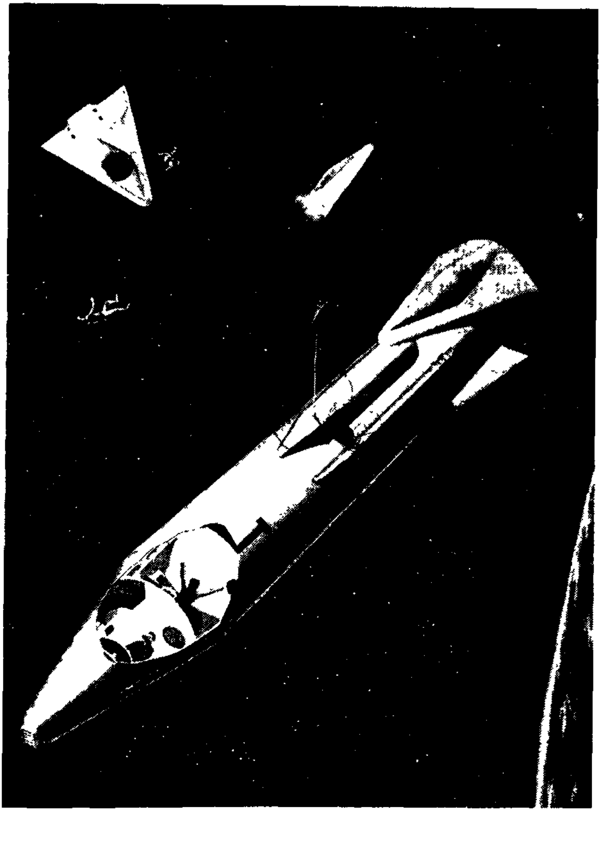
First step in establishing a permanent 4-man Atlas space station would be the placing of an Atlas intercontinental ballistic missile (1) in orbit 400 miles above the earth to serve as the shell of the station. Atlas space station could be in operation within 5 years, according to Krafft Ehricke, assistant to the technical director of Convair (Astronautics) division of General Dynamics Corp., San Diego, Calif. After Atlas shell reaches orbit, supply vehicle (2) and personnel carrier (3) would be launched and guided to the station by proportional navigation. Both supply and personnel carriers are second-stage rockets boosted into space by other Atlases. Tip of cargo carrier (2) has been cut away in drawing to show method of carrying equipment to the space station. Personnel vehicle (3) carries two two-man gliders at tip that break away when orbit is reached. Crews would dock gliders at Atlas station by small steering rockets. These two gliders would remain at the station to serve as lifeboats. Crew exchange during construction and operation of the station would be by similar second-stage gliders. Station could be completely fitted out by three cargo carriers.



[Second of series of three photos]

EQUIPPING THE ATLAS SPACE STATION

Scene depicts an intermediate stage in the establishment of an Atlas space station 400 miles above the earth. The station, proposed by Convair (Astronautics) division of General Dynamics Corp., producers of the Atlas intercontinental ballistic missile, would provide an early capability for proving long-term human existence in the environment of space. The basic structure of the station (1), the propellent tanks of the Atlas ICBM, is in orbit at left, its cap removed for access. Crewmen have arrived in a glider (center, at bottom) which has been launched into the space station orbit as part of the upper stage of a modified Atlas. A rubber nylon inflatable capsule, which will form the living quarters aboard the space station, is being removed from a cargo ship (2) at right. The completed space station would weigh about 15,000 pounds and would remain in orbit indefinitely with the help of small control rockets. The Atlas orbital system was designed by Krafft Ehricke, assistant to the technical director of Convair Astronautics, San Diego, Calif.



[Third of a series of three photos]

COMPLETED ATLAS SPACE STATION

In this artist's sketch, a new crew is arriving at the Atlas space station (1) to relieve men shown in partial cutaway of crew's quarters. Gliders bringing new crew are shown at right after separation from second-stage Atlas rocket that brought them into the space station orbit 400 miles above the earth. Cutaway section shows recreation and dining area, left, and sleeping quarters. Space suits needed for leaving the station hang on hooks against the walls. Station is entered through basket-edge manhole in side. Near it is dish antenna for communication with earth. Two personnel gliders that have been retained as lifeboats are attached to either side of the aft end of the station. Still farther aft is the auxiliary nuclear power plant, with its rectangular radiating surface to dissipate excess heat. The space station could be established within 5 years under a proposal made by Convair (Astronautics) Division of General Dynamics Corp. The station itself would be built into the empty propellant tanks of an Atlas intercontinental ballistic missile that has been stripped of its weapons equipment and launched into a 400-mile orbit. The Atlas would also be used to boost away from the earth the second-stage rockets that would carry cargo and men to the station. The proposal is the design of Krafft Ehricke, assistant to the technical director of Convair-Astronautics, San Diego, Calif., where the Atlas is in pilot production.

Mr. EHRICKE. What you see here is the layout and the design of a small experimental manned space station. It is based on the Atlas vehicle in that it represents essentially the Atlas propellant tank as such. That is the Atlas propellant tank. We have added certain equipment here and we have added other equipment there that normally is not attached to the Atlas.

The advantage of this system is that you can use the ICBM, the Atlas, and fire your basic structure, the basic tank, right out into space, and then you follow up with passenger and cargo vehicles.

I would like to show one picture that will illustrate this particular point. The orbital system as such consists of three vehicles which are shown here. The first vehicle is the Atlas itself, essentially unchanged. You take, however, all its war gear and its payload and everything out, you make it as light as possible, you have no payload. It just barely carries itself up there, but it is the only one that can do this particular thing.

Then you have another Atlas equipped with a small higher energy upper stage, the one I mentioned before in my statement. This is the same booster Atlas in the same upper stage. Now, it can carry either cargo or passengers. The passenger system here is so designed that you have two lift drag bodies, one of which seats a crew of two, and these two lift bodies are put belly-to-belly on top in the nose of the fuel system. The ship in itself, the passenger vehicle, is shown here with the two gliders, belly-to-belly, attached on top of the upper stage of the Atlas.

You see also the cargo ship, the cargo version. They are both the same. You see the basic Atlas tank. This particular version can carry about 8,000 pounds payload in this 400-mile orbit. So you go ahead and shoot the basic Atlas in the orbit and you have the empty shell which serves you as a meteor pumper and for temperature control. It is like the eggshell protecting the soft interior.

Then you send up a cargo ship and send up a passenger ship with these two twins, belly-to-belly, mounted on top. Then begins the interior decoration of the system. This is organized as follows:

On that end you have the passenger and use quarters. On that end you have the heavy equipment and supplies, and far out you have the nuclear auxiliary power system.

Now, first you bring up heavy equipment and you install it all the way back here. The reason for this being that you want the center of the mass of the system later to be as far back as possible because we anticipate that the station is going to be rotated like this in order to put the use of centrifugal force in that direction.

As you may know, the centrifugal acceleration is equal to the distance R times the square of the angle of velocity. And for a given angular velocity, therefore, it is directly proportional to the distance. The longer the distance, the less fast you have to rotate. The less fast you have to rotate, the less travel you get from the Coriolis effect. So we put all heavy equipment way down there.

After we have done this, we establish the living quarters. The living quarters come up in inflatable or come up in collapsed form. It is an inflatable rubber nylon bag that is being brought in here. This part, incidentally, can be taken off during the mounting. It is put in and then inflated and then connected.

Mr. McDonough. What is the altitude you are doing that at?

Mr. Ehricke. Four hundred miles altitude in an orbit. The work would go on as shown here; for instance, here the people are just pulling out of the supply ship, the collapsed living quarters are in a net and they pull this over to the space station and then put it in here. That is done in space itself.

Mr. McDonough. What is the temperature up there?

Mr. Ehricke. That depends on the reflectivity of your suit. You can have the temperature so that it is comfortable about sixty-five degrees Fahrenheit.

Mr. McDonough. In the suit?

Mr. Ehricke. Yes.

Mr. McDonough. The outside temperature you do not know?

Mr. Ehricke. There is no outside temperature because there is no gas, it is vacuum. The temperature depends on the amount which you absorb. It gets very cold on the shadow side of the earth, but the space suit has a heating system incorporated in it.

Mr. Ford. Are the guidance systems such that you can bring them together at such a point that a transfer or accumulation can be made?

Mr. Ehricke. That is possible, sir. One can use a technique that is known, in interceptor development as proportionate navigation. In other words, you lock onto the station, like you would intercept it with a hostile intent, only in this case you do not really intercept it, you get close to it.

When people are up there, they will send a beam and guide you in like an all-weather system guides you into an airport.

Mr. McDonough. This whole mass, all the equipment and the man you have the model of, are traveling at what speed?

Mr. Ehricke. At an approximately 17,500 miles per hour. It is not exactly any more than 18,000, it is a little bit slower.

Mr. McDonough. The man does not feel the speed?

Mr. Ehricke. No, sir. To them they seem to stand still and the earth is slowly rotating underneath.

Mr. Fulton. If there is only 5 miles difference between 2 certain satellites, 5 miles an hour difference, there would only be a bumped fender if they collided, even though they are going each 17,500 miles and 17,505 miles respectively?

Mr. EHRICKE. Yes, sir. This relative difference would be comparatively small and they would be reasonably protected.

After the bubble is installed, itself, you make the necessary connections and interior equipment.

You see here on the outer end where the gravity is highest, you have the sanitary room. That means washroom, and so on.

Way down here you have the collection of waste water from the washroom, as well as from the next floor, the food dispensary.

You see, water is something very heavy and we need it in rather large quantities normally. We cannot afford to carry all that water all the time up, use it and then throw it into space. So we collect it like the famous box in the airplane, but then we go one step further; we boil the whole stuff electrically to evaporate it, it is a distillation process. Then the vapor is being ducted into a condenser system which is regulated by a photosensitive element. So if it points in the sun, it closes. If it points away from the sun, then it opens up and it radiates the heat out.

So out here, the steam condenses into pure water again, clean water. You have the necessary chemical means. This is a technique that is well understood already today. The pure water goes into the water container and can be drawn out again.

Now, nonusable residuals are being flushed by means of air pressure out into space through a special waste-disposal outlet.

Here you have the dispensary and recreation room. Here you have the sleeping room, and up here you have the control room, laboratory communications centers, and so on.

Now, the structure here is not pressurized. So if a meteor goes through, it does not hurt you, there is no air inside. Only this part of the bubble is pressurized. Therefore, you need an air lock here. You close this air lock. For instance, if you want to go out, this would be closed and you would put the necessary air in here, then you open on the inside and go in, close on the inside, pump the air out into this container until it is completely equal and then you open this door and you go out. Then you are out in this house.

You can get out of the house by this manhole here. You can get out and in through this one here. The basket is just for safety reasons.

Way back here you have the odor absorber. You see, you have one other cycle and that is the air cycle. Unlike the water cycle, which brings the water completely back and can be reused, the air cycle is not a closed cycle as far as the oxygen is concerned. But it is a cycle as far as the nitrogen and helium is concerned that you have mixed to your oxygen. Fresh air is being pushed into a fresh air circulatory system. Each cabinet has its own fresh air circulatory system. All these guys are living better than some people on the surface of the earth.

Mr. FORD. Why are they horizontal?

Mr. EHRICKE. The reason is that this station is falling freely, the only weight is due to their rotation. So down is in this direction and up in that direction.

Mr. FULTON. Why do you not put a sky anchor out behind the capsule so that when it is rotated it does not rotate at a focal point within the axis of the capsule but clear out behind, so that you get a more simulated gravity?

Mr. EHRICKE. This could be done. This is principally possible. But in this particular case it was not necessary. We have another design of a more advanced station where this particular hub point is indeed out on a cable.

Mr. McDONOUGH. What is the little screen above the entry point?

Mr. EHRICKE. This is an antenna to maintain connection with the earth.

Then the air is being used up, going back through the cycle. You have CO_2 and so on and various other things, and you get in here first an odor absorber and then a regenerator and purifier. After you have done this, you have clean helium or clean nitrogen again. Then you add from the oxygen. The air is clean, but it is still warm. You cool it by the water content. It will gradually be warmed up again so you have lukewarm water.

Mr. McDONOUGH. You never have more water than you take up, but you lose some?

Mr. EHRICKE. You lose some. You have to supply it from time to time.

Mr. McDONOUGH. You cannnot produce it up there?

Mr. EHRICKE. No.

Mr. McDONOUGH. So far as the interior temperature is concerned, how do you regulate that?

Mr. EHRICKE. The temperature is being regulated by cooling the air. You have a constant air conditioning in your whole system. In other words, the air is never stagnant. It is being softly blown in one end and softly sucked out in the other.

Mr. McDONOUGH. Are there means for cooking food on board?

Mr. EHRICKE. This would be done essentially electrically. Much of the cooking would be done in closed containers to confine the distribution of odors as much as possible. I do not think people will be able to just cook everything there in an open frying pan because this gives too many odors. There are ways and means to keep this down so as to keep down the amount of odor absorber that is required here.

Mr. McDONOUGH. You have no outside ventilation coming into the cabin?

Mr. EHRICKE. No, sir; it has to be a closed system.

Mr. FORD. When is this feasible from a practical point of view?

Mr. EHRICKE. I would say about 5 years from the time we are permitted to go ahead. If tomorrow we were to get the order to go ahead with this project, 5 years from now it would be in a complete form.

Mr. McDONOUGH. What would it cost?

Mr. EHRICKE. Roughly $500 million to develop those upper stages and get the whole system functioning and setting up a station. Later on, in order to supply it, you need only one or two supply flights per year to replenish the stations nonrecoverable systems such as a little bit of water that gets lost, a little bit of air may get lost. Oxygen gets lost completely all the time. This has all to be replaced.

Then the people need fresh food and other material for their regular living and this has to be supplied. We calculated that 4 people in this station here would, over the period of a year, need 7,200 pounds of nonrecoverable supplies.

One cargo ship here, of the type I pointed out to you here, carries about 8,000 pounds of supplies. So it is fair to say, with this kind of cargo ship, one to two supply flights would suffice, but this does not determine the cost of maintaining the station because we do not yet know how often we have to rotate the personnel. If you have to rotate the crew, let us say every 2 weeks, then you would have to have 26 additional supply flights to get the people up and down. So, depending on how often you rotate the people, this would determine the cost of maintaining the station.

Mr. FORD. What is the purpose?

Mr. EHRICKE. There is a great variety of purposes. The main purposes are the following:

We do need a test bed in space. More and more people will press for it, I am sure.

We have now these chambers at Randolph Field where Farrell was sitting in. We have experiments at Wright Field where four people sat in the B–36 and so on, but this is only a partial simulation.

We need a station in which we can test equipment and gear that we later will need for deep space explorations.

We secondly need a test bed to test the crew, to really exist under actual space conditions.

The first crew that travels to the moon, or goes down to the surface of the moon, will not start being on the surface of the earth and just living a normal life and all of a sudden going out into space and being forced there for a week, and in case you go to Mars or Venus, much longer.

They will have to go through space-flight simulations like this one, and this is what gives you the space flight simulation.

Then you have the geophysical, weather observation and these things.

You can also launch artificial comets in the outer solar system and, of course, heavy satellites to Venus and Mars much more than from the surface of the Earth.

Mr. FULTON. Why is the best shape in the form of a tube instead of flying saucers or sphere?

Mr. EHRICKE. Let me say this: if you don't want gravity, if you don't want any centrifugal force, the shape plays no role whatsoever. Any shape is good enough. As long as you want centrifugal force, you want to have the lifting force as far away from the center of the rotation—you can do this with a minimum of material if you have just one tunnel between your hub and your crew.

If you have a ring, then you must make the diameter of the ring very large and your circumference goes up very, very much.

For small stations this is impossible to do. So if you take the doughnut shape you are forced right away into a big-station design.

Mr. FULTON. If you slip and fall out of the open hole at a point other than the point where the rotating is made, what would happen to you? Would you go right along with it as if you were a satellite yourself?

Mr. EHRICKE. You would have a slight additional velocity component due to the centrifugal force. If you all of a sudden were thrown out here, if all of a sudden the floor fell out and you would be hurled right out while you were in the bathroom, you would be hurt because you would not have your space suit on.

Let us assume you had a space suit on, you would go with the station.

Mr. FULTON. That is why you put it away from the fulcrum or turning point?

Mr. EHRICKE. That is why the entrance must be close to the tunnel point so you are not being thrown around in space by the centrifugal effect because here the centrifugal effect is practically zero.

Mr. McDONOUGH. Where is your navigating gear? Supposing one wants to come back to earth, who decides that and how is it done?

Mr. EHRICKE. I believe the decision as to whether the crew comes down will be made by whoever directs the project.

Now, as you can see here on this particular picture which shows the station fully assembled, you have two emergency gliders attached on each end. This is not shown here. They would sit here and there. If an emergency comes up, then the crew takes to these sorts of lifeboat rockets and goes down into the atmosphere.

They probably don't care where they land as long as they get away alive.

In a regular procedure the crew will be informed at some particular time, "4 hours and so many minutes from now supply ship number so-and-so will come up with a crew of 4 to relieve you boys in the station."

They will get ready, make all the preparations for leaving this and having the other guys taking over.

Then they take the 2 gliders with which the relief crew has come up and bring those 2 gliders back to the earth again together with themselves.

So the emergency gliders attached to the station will normally never be touched like a lifeboat rocket will never be touched except in an emergency. So the control of this will be from the earth.

They get exact instructions as to timing, flight direction, plus duration, and so on, that they have to fly. This will all be calculated on the surface and they get that command like a pilot today gets his commands from the ground, you do this and fly so high, now you go down to that level, if they have these waiting times.

Mr. FULTON. Where are the heating element and the communicating equipment?

Mr. EHRICKE. The heating element is way over here. There is a small nuclear reactor about 100 kilowatts total power output. It has about 800 pounds of water and lead in here for shielding purposes.

This gives you a shielding that shields the whole station so there is nothing actually affected by deadly radiation.

The rest here partly house your turbine, generator, recuperator, your rectifier and the rest is to get the weight further back and get the shielding down because the farther away you have the less weight you have to have for shielding.

Mr. FULTON. Can you use solar energy?

Mr. EHRICKE. Yes, however, primarily, we rely here on the reactor because the orbit of this station is not laid in such a form that you are always in sunshine. There is, incidentally, emergency electrical power equipment in the rear in the form of batteries.

I foresee for this station either an equatorial or polar orbit. In either case you are for a considerable length in the shadow of the earth and you could not use solar power.

In that case nuclear power is used.

Mr. FULTON. That instrument is no further ahead on development than you originally were when you worked on the V-2 rocket development?

Mr. EHRICKE. That is right. This is a relatively primitive thing we could start on right away, of course, incorporating the improvements that come up in 5 years, but it gives us the space capability and then the option to go ahead from that.

Mr. FULTON. If we had a lead and had the daring that you had when you advanced the V-2 rocket program, we in the United States would be launching on a program of this spaceship type at the present time.

Mr. EHRICKE. Yes, sir; this is correct.

Mr. NATCHER. Are there any other questions on either side?

Mr. MCDONOUGH. What about the spaceship that Lockheed is building at the present time?

Mr. EHRICKE. The Pied Piper project?

Mr. MCDONOUGH. Yes.

Mr. EHRICKE. This is an upper stage of slightly lesser performance than I have anticipated here. We could use it for supply flights. I think it is a very valuable project right now.

Mr. MCDONOUGH. They are putting the hardware together on that, are they not?

Mr. EHRICKE. That is right. We can put hardware together as soon as we are given the permission to go ahead, either by NASA or ARPA.

Mr. MCDONOUGH. In addition to Pied Piper, what other spaceship is there at the present time under production?

Mr. EHRICKE. To my knowledge, none, sir.

Mr. NATCHER. Mr. Ehricke, on behalf of our chairman, Mr. McCormick, and the other members of the committee, I want to thank you for your very fine statement and your appearance before the committee at this time.

Mr. EHRICKE. Thank you, sir.

Mr. NATCHER. You have made a fine presentation, Mr. Ehricke.

In fact, I would like to say to you advisedly that no other witness has appeared that has done any better. We certainly appreciate it.

Mr. EHRICKE. Thank you.

Mr. FULTON. I compliment you, too, sir.

Mr. EHRICKE. Thank you.

Mr. NATCHER. If there are no further questions, the committee stands in adjournment until 10 o'clock in the morning.

(Thereupon, at 5:20 p. m., the committee was recessed, to reconvene at 10 a. m., Thursday, April 24, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

THURSDAY, APRIL 24, 1958

House of Representatives,
Select Committee on Astronautics and Space Exploration,
Washington, D. C.

The committee met, at 10 a. m., pursuant to recess, in room 356, Old House Office Building, Hon. John W. McCormack, chairman, presiding.

Present: Representatives McCormack (chairman), Brooks, Hays, O'Brien, Metcalf, Natcher, Sisk, McDonough, Fulton, Keating, and Ford.

Also present: George J. Feldman, director and chief counsel.

The Chairman. The committee will be in order.

The first witness will be Maj. Gen. Bernard A. Schriever, commander, Air Force Ballistic Missiles Division.

We are glad to welcome you, General Schriever. Do you have a prepared statement?

STATEMENT OF MAJ. GEN. BERNARD A. SCHRIEVER,[18] COMMANDER, AIR FORCE BALLISTIC MISSILE DIVISION, UNITED STATES AIR FORCE

General Schriever. Mr. Chairman, I do not have a prepared statement. I am here to assist you and your committee in any way that I possibly can.

I do not have a prepared statement, but I have seen the statement that General Putt submitted and those of several other witnesses, related to the Air Force program, and I did not think I could add too much to what has already been said, but I shall be responsive to the questions you have.

The Chairman. How important do you think is the establishment of an agency in connection with the exploration of what might be termed outer space?

General Schriever. My feeling here is that the exploration of outer space should not be solely a military province. I think that there should be a civilian agency but I think any civilian agency that is established should not have an inhibiting influence on the military's being able to carry out its requirements in this very important area of the future.

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[18] Schriever, Bernard A(dolf) (schree ver), air force officer; b. Bremen, Germany, Sept. 14, 1910; s. Adolf and Elizabeth (Milch) S.; brought to U. S., 1917, naturalized, 1923; B. S., Texas A. and M. Coll., 1931; M. A., Stanford, 1942; Nat. War Coll., 1949–50; m. Dora Brett, Jan. 3, 1938; children—Brett A., Dora E., Barbara A. Became flying cadet A. C., U. S. Army, 1932; commd. 2d lt. A. C. Res., 1933, advanced through grades to big. gen., 1953; chief staff Far East A. S. Command, 1943–45; assigned hdqrs. USAF, 1945–49, 50–54, asst. for development planning, ast. to comdr. Research and Development Command, 1954—. Decorated D. S. M., Legion of Merit, Air Medal, Purple Heart. Home: 603-25th St., Santa Monica, Cal. Office: 401 E. Manchester Blvd., Inglewood, Cal.

The CHAIRMAN. Projecting your mind, based on your knowledge and talks with others of competent ability, how important do you consider that research and technology are in connection with the national interest of our country in the field of what might be called outer space?

General SCHRIEVER. I think, first of all, we can identify certain military applications to ballistic missiles. The ballistic missile, for example, is a member of the space vehicle family.

Satellites for reconnaissance, communication purposes, have direct military applications.

There are other things that are less clear as to direct military applications for, say, putting man into space. We certainly have a lot of scientific data that we can get from exploration of space. There is certainly prestige involved in moving forward in that area which I think is an important element in the world today.

It is impossible, I would say now, for any man to predict exactly how important space will be for military purposes, looking into the future, 20, 30, or 40 years.

I feel strongly that we must put man in space. No matter how automatic you make machines the human mind is still superior to any machine that you can make. I am certain that we will find a very useful purpose for man in space and, therefore, I think a program leading to this is very essential.

The CHAIRMAN. Do you consider that it is important for the Congress to pass a law establishing a civilian agency that will recognize the immediate problems that confront us and the world from a military angle?

General SCHRIEVER. I feel strongly that the military should be permitted to carry out its own research and development for vehicles which have application for military purposes because it is important that the developer and the user work together.

However, there are many things that would only have a vague military application and these, I think, would properly fall under a civilian agency.

Furthermore, I think the scientific element in the country needs to have a greater outlet for exploration of space than might be provided to them if they solely used the military for that purpose.

The two agencies, the military and any civilian agency that is established, must, of necessity, work very closely together.

The CHAIRMAN. I do not think there is anyone on the committee that fails to recognize that fact, General. We are all practical men.

But it is your opinion that it would be desirable for the Congress to establish an agency of the nature proposed in the pending bill, along the lines of the pending bill?

General SCHRIEVER. I have not had time really to read exactly what has been proposed. If you are talking about the NASA, I have read enough to understand generally how this agency is to operate.

Certainly for one, I strongly favor using the NACA as a building block for this agency because we in the military have had long working relationships with that agency and they have been extremely satisfactory. We understand each other; procedures have been established; you have a body in being which you can build from.

So I would strongly favor that approach.

The CHAIRMAN. I will not ask any more questions. I just thought I would lay a foundation here because you are starting from scratch and submitting yourself to questions.

Mr. Brooks.

Mr. BROOKS. General, I am glad to see you back here. I have heard you testify previously and I think you are doing great work there in charge of the Ballistic Missiles Division of the Air Force.

We had a demonstration yesterday from the Ballistic Missile Division of the Air Force. Can you give us an insight of what happened yesterday?

General SCHRIEVER. At this moment, I cannot add anything. We have gotten some conflicting data. It takes a while to evaluate all this—our telemetering data and our optical and photographic data.

I think it will be a couple of days before we get a complete evaluation of the test. We have not recovered the nose cone—I can at least tell you that. I am not sure that we will recover the nose cone but at this moment I don't have any other information.

Mr. BROOKS. If you do not recover the nose cone, you will not be able, then, to find out what damage, if any, it sustained in returning to the atmosphere?

General SCHRIEVER. That is right. If we do not recover the nose cone the test has to be considered as only partially successful.

However, we do get telemetering data from the nose cone during its reentry flight, which, of course, gives us valuable data as to what happened. Recovery would be important in this instance, however.

Mr. BROOKS. Did you get the data on its reentry into the atmosphere?

General SCHRIEVER. We had ships down range. I have not gotten a report from them yet.

We did get telemetering data as far down as Antigua, which is about 1,500 miles down range, but that is not at the reentry point.

Mr. BROOKS. The press carried something to indicate that it was better than 5,000 miles. Is that correct?

General SCHRIEVER. We did not make such a release; no, sir.

Mr. BROOKS. I think the press carried it. Maybe they got a release from the code signals that were sent out.

General SCHRIEVER. They might have.

Mr. BROOKS. It has been suggested that this would be a proper question: How far was that to go? That was not a shot at the moon, was it?

General SCHRIEVER. No, sir.

Mr. BROOKS. How far was it desired for it to go?

General SCHRIEVER. There are certain things I cannot say for security reasons, but I can tell you it was a reentry test aimed at getting reentry data at ICBM ranges. ICBM ranges are anywhere from 3,500 to 5,500 miles.

Mr. BROOKS. So you intended to do better than 3,500?

General SCHRIEVER. Yes, sir.

Mr. BROOKS. The Ascension Islands are about how far from Banana River?

General SCHRIEVER. Forty-four hundred miles.

Mr. BROOKS. The press carried something about it. Supposing that the cone is lost and dropped in the sea below Ascension Island, that would be better than 5,000 miles.

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General SCHRIEVER. I can say that we had ships out on the range and that these were instrumented ships. The cone was intended to be recovered from the ocean.

Mr. BROOKS. You do not think it went over South Africa, do you?

General SCHRIEVER. I would like to think that it had, but I do not think it did.

Mr. BROOKS. Now, if you recover it, it will give you certain data. The cone that was recovered sometime back, which reentered, came back with substantially no damage to it. Is that right?

General SCHRIEVER. Let me say it was a successful reentry test from all the information I have on it, yes. That was the Army test.

Mr. BROOKS. You would not say it was not damaged? I saw it and it did not show any damage.

General SCHRIEVER. I do not know what you mean by damage. It was a successful reentry. It was not damaged in the sense of not being able to perform its mission.

Mr. BROOKS. You, as a technician, will use that term. I will say it was not damaged.

General SCHRIEVER. I will say it was not damaged, also, then, just to keep the record straight.

Mr. BROOKS. Now, is it the purpose of these ballistic missile tests to try to send one to the South Pole?

General SCHRIEVER. We have no such plan at this time.

Mr. BROOKS. Did the mechanism aboard this missile, which relayed back the information, perform satisfactorily?

General SCHRIEVER. Not completely.

Mr. BROOKS. In what respect did it fail? Most of this is already in the press, you know. That is the reason I am asking.

If it was something that was not in the press, I would not ask you about it, but we might as well have the official details as well as read them in the press.

General SCHRIEVER. I did not make this release to the press.

Mr. BROOKS. It was a pretty good release, was it not, General?

General SCHRIEVER. The release that was made simply said that we had made this test, that this was the first of a series of reentry tests, and that we were going to attempt recovery. That was the last release made.

Mr. BROOKS. Will you tell us how high that missile went before it started back on its return trajectory?

General SCHRIEVER. No, sir; I do not know actually how high it went. We do not have that data yet.

Mr. BROOKS. I understand it used a portion of the Explorer. How did that function? Was that a satisfactory arrangement?

General SCHRIEVER. We used the so-called Vanguard second stage. Actually, the engine was developed by the Navy for their Vanguard program. It is an Aerojet engine and we used that engine as the second stage. It is, you might say, a modified Vanguard second stage.

Mr. BROOKS. The press says that you proposed to use the Vanguard for a third stage, too, in the tests coming off in the near future.

General SCHRIEVER. Of course, there is a good deal of speculation about how we are going to do certain things—things about which no information has been officially released to the press.

Mr. BROOKS. The articles I read in the press were not very speculative. They were rather definite.

The counsel tells me that Dr. Hagen mentioned it in his testimony the other day.

Is it proposed that your tests will go right on through, but will be interrupted by other tests of Vanguard, for instance?

General SCHRIEVER. Our tests will go right on through.

You see, Vanguard has a launch pad adjacent to one of our launch pads for the Thor program. They have one launch pad, we have three.

There is little or no interference between the tests.

Mr. BROOKS. You are not prepared, though, to launch two at the same time, one from the Navy and one from the Air Force, are you?

General SCHRIEVER. We have launched more than one missile a day. We have launched as many as three missiles from Cape Canaveral in a single day.

There is some interference probably when you launch more than one, but this can be worked out.

Mr. BROOKS. Have you launched three major size missiles, or satellite type missiles?

General SCHRIEVER. No, not major missiles.

Mr. BROOKS. They were smaller missiles?

General SCHRIEVER. We launched 2 large missiles and 1 small missile in one day at the cape several months ago.

Mr. BROOKS. What would you say about the accuracy of the medium-range missile now? Have we developed it to the point that it is dependable and accurate?

General SCHRIEVER. We have had very successful guidance flights with the Thor.

The problem of reliability is still one of our major problems, and it will continue to be. That is one reason why we have to test as many missiles as we do—to build up the reliability.

Unfortunately, missiles are not like airplanes. You can take an airplane up and bring it back down again for inspection and analysis. Fire a missile, though, and you've had it as far as that particular missile is concerned.

Our program contemplates the firing of a considerable number of missiles in the development program and one of our major objectives is to improve the reliability as we go along. We know from experience this is necessary.

Mr. BROOKS. And the responsiveness, too? Did you control that missile until it hit the water or land or its destination?

General SCHRIEVER. Yesterday's was not a guided flight.

Mr. BROOKS. It was not guided in any sense of the word?

General SCHRIEVER. The missile had a control system and automatic pilot, but it was not guided in the sense of having a guidance system with which you attempt to hit a pinpoint target.

Mr. BROOKS. You had no land control, then? Is that what you mean?

General SCHRIEVER. Yes, all these flights are programed flights and we can predict quite accurately the area in which it will impact. By a "programed" flight I mean one in which the missile trajectory is computed and introduced into the guidance system before launching.

Mr. BROOKS. You have control from some land areas. Was your control of that missile effective?

General SCHRIEVER. The controls are part of the missile itself. One portion of the control system is the automatic pilot. The missile, of course, is radar tracked from the ground during its powered flight so that in case it goes off course and endangers any land areas, it can be destroyed by a signal from the ground.

Mr. BROOKS. You can destroy it then and have that much control over it. You have some control in the direction and elevation, do you not?

General SCHRIEVER. Not from the ground on this type of flight. There are different types of guidance systems, too. The intermediate missiles for example, use what we call an all-inertial guidance system. This system has all its guidance equipment actually on board the missile and follows a trajectory which is programed prior to launching. It is not controlled from the ground at all.

Mr. BROOKS. Is this the fish-out-of-water type operation that has been referred to before this committee previously?

General SCHRIEVER. That term does not ring a bell with me, sir; I am sorry.

Mr. BROOKS. That is sending up a missile until it jumps out of the atmosphere into space and then returns into space.

General SCHRIEVER. Yes, sir; all of our longer range ballistic missiles move through the atmosphere, operate in space, and then return.

Mr. BROOKS. Was there any effort to get the elevation there on that flight, or was that the range that you had an interest in?

General SCHRIEVER. You have to get elevation in order to get range.

Mr. BROOKS. Your prime purpose was the range?

General SCHRIEVER. The prime purpose was the range; yes, sir.

Mr. BROOKS. The elevation was only incidental, as it would lengthen the range?

General SCHRIEVER. That is right.

Mr. BROOKS. There was nothing alive aboard their satellite; no animals?

General SCHRIEVER. Yes; however, this was primarily the first of a series of our long-range reentry tests. Although the vehicle was primarily designed to obtain reentry data for a nose cone of advanced design, we were also able to place a mouse on board and thereby accomplish additional space research.

The mouse was carried in a specially fabricated compartment within the nose cone equipped with air purification and breathing apparatus. The experiment was conducted under the supervision of the Aeromedical Field Laboratory and was designed to help identify and solve such problems as weightlessness and other factors which will affect man in space.

Mr. BROOKS. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Metcalf.

Mr. METCALF. I will reserve my time, Mr. Chairman.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. General, in your opinion, will we be able to shoot a rocket close to the moon by the year 1960?

General SCHRIEVER. Yes; we certainly can. In fact, the Air Force is planning an attempt late this summer.

Mr. NATCHER. General, do you further believe that by the year 1966 we will be able to land on the moon?

General SCHRIEVER. You mean with a man? A vehicle fully instrumented and sending a manned rocket? In talking about this, I would like to specify that I am talking from my own personal opinion and judgment.

Mr. NATCHER. That is right.

General SCHRIEVER. My technical opinion is that there is no reason why we cannot land on the moon by that time period, 1966.

Mr. NATCHER. Further, in your opinion, General, do you believe that by the year 1970 we will be able to establish a permanent base on the moon and have a supply system set up to maintain the base?

General SCHRIEVER. This might be possible, but it would be very expensive to accomplish this by that time.

Mr. NATCHER. Give us some idea, General, approximately. I know you are not able to fix the amount, but approximately how much would you say such a program would cost?

General SCHRIEVER. I would really have to pull this out of thin air, because I have not actually given much thought about setting up a station on the moon, although I have read about such schemes.

The cost certainly would be in the severals of billions of dollars. This estimate, however, is not associated with the first question that you asked with respect to the moon.

Mr. NATCHER. General, as I understood your answer a few minutes ago, you have read the bill that is before the committee that sets up this Agency as far as outer space is concerned.

General SCHRIEVER. No, sir; I have not read the bill.

Mr. NATCHER. Assuming that this bill provides for an agency controlled by civilians, a civilian-controlled agency, in your opinion, General, would that be the best procedure?

General SCHRIEVER. I think it would.

I also want to qualify my answer by saying I feel also that the military must carry out their proper portion of any space program.

Mr. NATCHER. I understand.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. General, as I understand your answer, then, to the gentleman from Kentucky, you have not read the bill?

General SCHRIEVER. No, sir.

Mr. SISK. Are you generally familiar with what it proposes to do in the type of agency it proposes to set up? I believe the bill calls for a 17-man board, directors, and so on.

Are you familiar with that proposal?

General SCHRIEVER. I would say generally I am. Its functions would be different from those of the present NACA, which is really a committee.

The CHAIRMAN. That is true, General. At the present time the Board is really the operating level in the present setup and the Director is under the Board. Whether in practical operation he is, that may be a different proposition. But this, in substance, would set the Board under the Director and principally in an advisory capacity.

Mr. SISK. Thank you, Mr. Chairman.

Let me ask you this question, General. What is your opinion of ARPA, the Advanced Research Projects Agency?

General SCHRIEVER. Well, I got myself in trouble on this one once before.

Let me say that when I testified previously on this subject, I did so before the group was actually set up. I stated that I felt such an agency at the Department of Defense level was highly desirable, provided that it would be positive, constructive, and one which could establish policy and make decisions in this whole area.

I felt that such an agency should use the operating management which was available to it within the three military services. If it did that, then I thought this was a constructive step.

Up to this point ARPA appears to be doing that.

In other words, they are using the service management organizations that exist and in which we have technical teams, procurement teams, and management organizations in being.

For example, they have directed my organization to undertake a part of their overall lunar probe program. This seems to me a step in the right direction.

Mr. SISK. None of these questions, General, are intended to put you on the spot. But we have been delegated certain responsibilities here, we have before us certain legislation, and we are going to be called upon to make some recommendations.

I am merely interested in your opinion on some of these things. It had been my understanding that at the inception you opposed the Advanced Research Projects Agency. I have no desire to put you on the spot, but I wondered what you think of it since it was established.

General SCHRIEVER. In the early thinking they seemed to be considering a big operating agency. I saw some of the draft proposals. This concept I did oppose.

However, I have no fault to find with their initial operating arrangements, and so long as they continue to function as they are doing now, I think they will be a highly constructive element within the Department of Defense.

Mr. SISK. Do you feel they have tended to stabilize the program?

General SCHRIEVER. They have been helpful in laying the base for an astronautics program.

Mr. SISK. Correct me if I am in error, but I think in the past you indicated you felt that it took altogether too much time to get decisions from Washington. Do you feel there has been any improvement, or any change in that situation since you made earlier statements, if the statements are correct?

General SCHRIEVER. I did make such statements. The trend is now in the right direction, however. I guess that when you are at the operating level, as I am, you are never quite happy with the time it takes to get decisions made by higher authority.

But I can honestly say that the trend in the decision-making process, as it relates to the program for which I am responsible, is in the right direction.

Mr. SISK. Now, in answer to a question from one of the other gentlement a few moments ago, you referred to the NACA as a possible vehicle or nucleus around which a new agency might be created.

To what extent do you feel that NACA has been successful in its objectives and in the handling of the program over a period of a great many years, I believe since 1915?

General SCHRIEVER. NACA has been in being, I think, quite a bit longer than that. We had NACA down at Langley Field when I first came to the Air Force in 1932.

Mr. SISK. Maybe you misunderstood. NACA was created in 1915.

General SCHRIEVER. I am sorry, I thought you said 1950, sir.

Mr. SISK. It has been in operation over 40 years.

General SCHRIEVER. Yes, it has been in operation a long time.

I have been in research and development in the Air Force on and off—mostly on—since 1939 when I first went to Wright Field. I can only speak with praise concerning the NACA and what they have accomplished.

For example, in our ballistic missile program they have given us very, very great support.

For example a very large part of the wind tunnel high-speed testing done by the Moffett laboratories in California has been in support of our nose-cone work.

The Cleveland Propulsion Laboratories have also done a lot of work in the rocket field for us.

So I think both from an accomplishment standpoint and from the standpoint of relationships with the NACA there has been a highly successful partnership. I know the Air Force, and I am sure this is true of the Navy as well. The Army has had less dealings with the NACA in the past.

Mr. SISK. General, if they are doing and have done a good job, what is the need of a new agency?

General SCHRIEVER. I would rather measure the need in terms of widening the scope of their responsibility. I consider it more or less in terms of the NACA taking this job on with, perhaps, a little greater authority and with a broader scope of responsibility. I think the transition from the earth's atmosphere to space is a natural one and, as a matter of fact, we have been operating on the edges of space with the Air Force's high-altitude airplanes for the past 5 or 10 years.

Mr. SISK. The mere fact that we upgrade the NACA and give it a new name, say, add space and add astronautics to aeronautics, is not going to change operations generally or widen the scope, is it?

General SCHRIEVER. They have not, specifically, had responsibilities out in space, as such. They have been associated with aircraft, and these aircraft have been traveling at very high altitudes.

Mr. SISK. Who does have authority in space, if they have not had it?

General SCHRIEVER. I do not think any agency outside the military has really been in that area.

Mr. SISK. Is there any restriction on them, or any other agency, as to the authority and responsibility for exploration in space? Have we limited it in any way?

General SCHRIEVER. I am not sure. I would have to read the charter of the NACA and make my interpretation. I think that Dr. Dryden, whom I have talked to, and also Jimmy Doolittle, feel there is a need for an expansion of the charter to incorporate astronautics, although I have not, specifically, talked to them about that nor questioned them about it.

Mr. SISK. So that we completely understand each other, there is nothing critical toward you or NACA in my questions. However, I am concerned over a great deal that has gone before and, particularly,

some testimony before this committee. Certainly it seems to me, if all we propose to do here is simply to upgrade and change the name, possibly even give a little additional responsibility to NACA, I question whether that is the answer. That is the reason, primarily, for these questions. Now, it certainly was not necessary to obtain any new legislation for you to go into space?

General SCHRIEVER. No.

Mr. SISK. So, there is no need for legislation to give NACA any additional authority to explore space or to consider space in their program, is there?

General SCHRIEVER. I am not entirely certain about that, sir.

Mr. SISK. This is the point that I had in mind, General. As I say, I am not critical of Dr. Dryden or of the NACA. I think that, over the forty-odd years they have been in existence, the record shows that, apparently, they have moved forward generally, but have we reached a stage, and are we in any position today, where their type of progress no longer meets the need?

General SCHRIEVER. At least the inference is that we should progress faster, but I am not sure that the NACA could not do the job under the present charter.

I think that, if you were set up a completely new agency starting from scratch, you would undoubtedly slow things up before you would gather the needed momentum.

You would then have another agency that would have to set up its administrative procedures and its working relationships with other agencies of the Government and with industry and so forth. I, personally, feel that the NACA is a proper approach to this job on the civilian side.

Mr. SISK. You do not feel that the NACA and its type of operation has, at any time, attempted to restrict freedom of operation by our scientific or engineering brains or minds in this country. You feel the hundreds of millions of dollars which, of course, they have had available, has been well spent, in your opinion. Is that right?

General SCHRIEVER. I think so; yes, sir.

Mr. SISK. Just how urgent do you feel this program is? By that, I mean this probing into space and conquering space, if you will permit me to put it that way, although I realize that we will conquer by degrees. To what extent do you attach urgency to this, General?

General SCHRIEVER. I would say that we should carry out a sensible program in the exploration of space. I would not attach the same degree of urgency to space exploration, per se, as I would attach to the development of those space weapons which will be vital to the national security during the next 10 years. I am talking now of advanced ballistic missiles and satellites and so on.

Mr. SISK. You think the emphasis should be on the military aspect, rather than on getting into outer space for other purposes?

General SCHRIEVER. I don't want to be exclusive here. In these matters there is always a question of priority, and there is always a question of how much of your reserves you can afford to put into these various ventures.

Now, there is no question but that we can do a great deal of exploration in space with relatively small additions to the present foundation that has been established in the military programs. I am not saying,

however, that we should try to do, all at once, all that may be technically possible.

We should make our resources available to a civilian agency. If they don't use them, the program will be extremely costly. It has already cost an awful lot to come as far as we have today.

Mr. SISK. To conclude this line of questioning, General, it seems to me we have two schools of thought: One seems to indicate business as usual, doing business at the same old stand, and by that I mean NACA, with a little upgrading. On the other hand, we have a school of thought that feels there is a certain urgency in this program; that we need to progress and place great responsibility in the Director, to carry forward much more rapidly than we have been. To what school do you belong, would you say?

General SCHRIEVER. First of all, I cannot, in my mind, divorce the military program from the so-called civilian space program. We have been and still are carrying out the military space program, first in ballistic missiles, and now in military satellites, under the very highest priority and with the greatest degree of urgency that I have known since I have been in the service.

I expect that space exploration will proceed at a pace that is pretty closely associated with that of the military program, because military resources will have to be used. However, it is my personal judgment that space exploration, in the pure research sense, does not carry so urgent a priority as does military space development, sir.

Mr. SISK. I have one concluding question, General Schriever. I believe I am correct in stating that you indicated that, by using our present hardware or available equipment, the IRBM and ICBM with boosters, we could put much greater weights into space and, possibly, get to the moon by 1959.

Would you want to make any comments on that? I am not quoting you; I am merely summarizing or paraphrasing what your position has been.

General SCHRIEVER. This is correct.

Mr. SISK. Do I understand that you are saying that you have hardware in being, as a part of the IRBM and ICBM, equipment, engines, products, boosters, with which we could put into orbit today much greater weights than we have heretofore?

General SCHRIEVER. Let me say this: You speak of "today." We are today only in the development phase. The idea I meant to convey was that the hardware which is under development in the ICBM and IRBM programs will put much greater weights into orbit than we have so far put up.

Furthermore, I have stated elsewhere that the hardware and facilities in these programs could provide as much as 90 percent of the hardware and facilities required in space exploration during the next 5 to 10 years.

Mr. SISK. That is all, Mr. Chairman.

The CHAIRMAN. Of course, General, the use of laboratories and facilities should be coordinated so that there will be no unnecessary building up of two parallel systems. Is that right?

General SCHRIEVER. That is right.

The CHAIRMAN. As I analyze your state of mind, you are recognizing what anybody should recognize, namely, the immediate situation that confronts the world and our country?

General SCHRIEVER. Right.

The CHAIRMAN. While we have a civilian Government, its survival is dependent upon military victory in case of war.

General SCHRIEVER. That is true, and I am sure you will agree that what we want to do is to remain strong enough so that we will not have a war. We can only do this by having the most modern weapons available, at least in view of the present world situation.

The CHAIRMAN. Nobody could disagree with that statement.

On the other hand, I am not an adherent in my personal views to a fixed policy of nonaggression. I am not particularly of that school. I never believe in advertising my punches completely to an enemy or potential enemy.

Mr. Fulton.

Mr. FULTON. Thank you, Mr. Chairman. I am going to limit my questions to 5 minutes on the nose, so that we will move a little faster.

When the rocket was shot into the air yesterday by the Air Force, it was a planned course and a planned target area, was it not?

General SCHRIEVER. Yes, sir.

Mr. FULTON. It has been said that the planned target area was in the vicinity of the Island of Ascension. That is correct, is it not?

General SCHRIEVER. Yes.

Mr. FULTON. It went over the regular missile course laid out from Cape Canaveral to the Island of Ascension. Can you tell us if there was any deviation in flight that would make the particular missile appear unmanageable or was it a successfully inertial guided mission flight?

General SCHRIEVER. It was a preprogramed flight using an automatic pilot. The missile was definitely not unmanageable; otherwise it would have been destroyed by range safety.

Mr. FULTON. So why do we not in the United States, and you in the Air Force, say that we are now up to where Russia has been on her ICBM, that we have had the equivalent of an ICBM flight that has been successfully guided on a program flight to a target area and it has reentered the atmosphere as scheduled? That is what Russia did in the latter part of August, last year. Why do you not make the same kind of announcement, that you are now equal with Russia on the ICBM planned and programed flight? It that not right?

General SCHRIEVER. No.

Mr. FULTON. Why is she then still ahead of us after what happened yesterday?

General SCHRIEVER. I do not think you can classify this missile as an ICBM. It was strictly a research vehicle to obtain reentry data. You must remember that in an operational missile the total nose cone-warhead combination dictates certain weight requirements. For certain test purposes you can use missiles of weights which are considerably less than might be required for an operational ICBM.

Mr. FULTON. As far as you know, from what Russia has released, this is the equivalent of her four-to-five-thousand-mile test going northeast over Astrakhan up into Siberia.

So why do you not say we now have the equivalent rather than hesitate and say we have not similarly had a 5,000-mile ICBM test, giving the size, that was according to a planned program and entered the correct target area on schedule?

That is what you did.

General SCHRIEVER. Well, we do not have all this data confirmed yet, as far as this particular flight is concerned. I want to make that point clear.

Mr. FULTON. Yes, but you know it entered the target area, do you not?

General SCHRIEVER. No, I do not.

Mr. FULTON. It went according to the program and plan. You telemetered it on a certain course and it was in the regular target area in the vicinity of Ascension Island. It may not have been seen to have plopped, but somebody knows it is in that area, does he not?

General SCHRIEVER. We do not have such data now that has been evaluated to completely confirm this.

Mr. FULTON. I am in the newspaper business. When you are in competition with somebody and you are in politics, you do not give the other guy the edge and minimize yourself. You just say you are equal to the other guy.

It is hard for me to get the Air Force to say they are equal to anybody in this race for propaganda.

As a matter of fact, from some information I have that is classified, I think you are equal on this particular flight and that you have had a space vehicle that has reentered on a program flight with proper decelerating devices and it has been telemetered, so that you are successful. Why do you not say it?

General SCHRIEVER. Well, I would like to say it.

Mr. FULTON. Then let us say it.

General SCHRIEVER. You are not going to get me to say it simply because, as far as this last flight is concerned, the data just is not in to the point where I can say it.

Mr. FULTON. Well, you promise to say it, if it is true and you can confirm it?

General SCHRIEVER. It still is not an ICBM.

Mr. FULTON. Is not a missile that is a space missile with a payload carrying ability which has a range of a programed flight over 5,000 miles an ICBM or am I wrong?

General SCHRIEVER. You do not have an ICBM until you have, first, discreet guidance, not just a programed flight by an automatic pilot, and, second, the weight-carrying capacity too for a significant warhead.

Mr. FULTON. Then do you believe that Russia's announcement of last August that she had successfully carried out an ICBM flight means the same thing that you are talking about?

General SCHRIEVER. I personally cannot give you an honest opinion on that. I have to take what the intelligence agencies say.

Mr. FULTON. If you will just say yes or no, or I do not know, that will help us.

General SCHRIEVER. I don't know.

Mr. FULTON. May I finish with this.

Krafft Ehricke, who is the preliminary designs chief of the Astronautics Division of Convair of San Diego, was here yesterday. He recommended immediately starting on a space ship that is not designed primarily for military purposes, but is maneuverable so that it might, in the long run, be so used. He estimated the cost of that as a half billion dollars.

Likewise, he said that on the capability we have now with on the Jupiter C and the Vanguard, as well as the Atlas and the Thor, we have thrust or booster power necessary to put that kind of space ship into outer space. Likewise, we can provision it by weekly or bimonthly trips.

First, do you think it is feasible? Second, would you recommend that such a program be undertaken by someone?

Third, would you recommend that the Air Force do it?

General SCHRIEVER. First, it is feasible, but certainly not in the immediate future.

Getting man up into space and providing the right kind of environment for him is still a major problem ahead of us.

Mr. FULTON. Then you would agree with Von Braun when he says it is important to put a man in a capsule and shoot him 150 miles in the air, or would you refer to it as did by Dr. Dryden, that it would be in the nature of shooting a woman out of a cannon? Whom do you agree with?

The CHAIRMAN. Or do you have your own views?

Mr. FULTON. Is it effective? Should it be done, or is it just like shooting a woman out of a cannon?

General SCHRIEVER. I think there are possibly more effective programs than doing it that way. There are a number of ways in which you can get man into space. A number of proposals have been made. I do not know that you gain too much by simply putting somebody up to 150 miles and then letting him come back down again.

Mr. FULTON. You would then advise against the program at this time as a practical matter?

General SCHRIEVER. I would advise against that one. I would much prefer a program in which we first orbit, say, animals, while, developing a recovery technique for the animals, and then go on to manned flight in that manner.

Mr. FULTON. Thank you.

That is all, Mr. Chairman. My time has expired.

The CHAIRMAN. We are very glad to welcome back to the committee Congressman Hays of Arkansas. I hope that on the floor of the House and when we have time to get into executive session, he may give us some of his impressions of his recent trip to the Soviet Union.

Mr. KEATING. I hope so, too, Mr. Chairman, and I hope he converted a good many there to the Baptist cause.

Mr. BROOKS. Mr. Chairman, I hope, too, he brought back some information for the committee on the question of Russian guided missiles.

Mr. FULTON. And I hope that when we send our Aga Khan, the head of the Southern Baptist Conference, that he is given his weight either in Arkansas cantaloupes or Russian watermelons instead of diamonds when you get over there.

The CHAIRMAN. Of course, you cannot let my church out, the Catholic Church. This is a little pleasant interlude, General.

General SCHRIEVER. Yes, sir; I am enjoying it, too.

Mr. KEATING. I yield to Mr. Ford, who has another committee meeting.

Mr. FORD. As I understand part of your earlier testimony, General, you indicated since 1939 you had been concentrating more on research for the Air Force.

General SCHRIEVER. Research and development: The only time I have not been directly associated with research and development activity for the Air Force was during the war, when I was overseas for three and a half years.

Mr. FORD. I believe that, at least in more recent years and perhaps in earlier times, you were in the research and development programs that were more or less of the advanced type?

General SCHRIEVER. My last assignment in the Pentagon was chief of the Development Planning Office which has the major objective of studying the next generation of weapons that the Air Force should be putting their money on.

Mr. FORD. In that capacity, I am sure, when you felt you had good ideas and good programs beyond the normal military scope, you have had some frustrations in trying to sell such programs, have you not?

General SCHRIEVER. It is always difficult to sell new programs.

Mr. FORD. It is difficult to sell new programs, particularly to those who have to meet conventional needs right at the moment.

General SCHRIEVER. There is always a compromise that has to be reached between a force in being and a force to be; a compromise between current production payments and the fund requirements to initiate a major new development program. There are always good and valid questions that arise, too, either from the technical, operational, or logistics standpoints, whenever you introduce a completely new operational environment or new logistics systems to support it.

Mr. FORD. I do not question the difficulty of making choices. However, I believe it is true that the establishment of your own agency in California made the job of getting the ballistic missile program advanced easier. Is that correct, General?

General SCHRIEVER. Yes; I think so. We did have the support of the Air Force right from the start and the ballistic missile program has been given the highest priority. I had this strong backing to begin with. The nature of our management organization has been such that we have been able to speed things up by taking concurrent action right across the board in all areas required to produce complete weapon systems and their operational and logistic environment.

In short, we are pushing the whole program forward on the broadest possible front—not just the research and development phase alone.

Mr. FORD. When you are operating with a new idea, intermixed with a lot of more or less conventional ideas, sometimes you do not get the needed emphasis on the new idea in relationship to the other.

General SCHRIEVER. I think this is true.

Mr. FORD. For example, it is true that since ARPA was established there has been a greater emphasis on the lunar probe program than we had prior to its establishment?

General SCHRIEVER. Yes. This is true speaking of the Department of Defense level, but there has been considerable interest in doing this, say, in my organization and also in the Army's organization.

Mr. FORD. I agree with that, but you did not get any action to proceed until ARPA took over the responsibility?

General SCHRIEVER. That is right.

Of course, it is very important that the right people be selected for ARPA. Now, Dr. York, who is an old friend of mine, is a very fine choice for the chief scientist in that organization. I do not know

Mr. Johnson, but he has certainly a good record and his office has been moving forward quite aggressively.

Mr. FORD. Using that as an illustration, is it fair to conclude that expanding NACA to an NASA might give the same impetus to the civilian side of space exploration?

General SCHRIEVER. I think that this certainly is a logical conclusion. I had quite a long talk on this subject several months ago with some of the scientists who are with Dr. Killian. I have known these men for some time, and they brought up this very point.

This was the reason why they felt it was a good and necessary move to establish an agency outside the military, with singleness of purpose with respect to exploration of space. From a philosophical standpoint, I agree.

Mr. FORD. It seems to me, if you look back over history, in recent years even, whenever we set up such an agency, and we have to assume it is well managed and has a good purpose, that it does seem to provide an impetus. It does seem to get action, which you have not been able to get heretofore, where the idea was crowded in with a number of other things which were, perhaps, equally important today, but not so important in the years ahead.

I gather from your testimony that since ARPA has been operating your relationships with it have been very satisfactory?

General SCHRIEVER. Yes. We, of course, run into certain administrative problems which you could expect, but we have ironed those out and in our opinion we have been working very well with them; yes.

Mr. FORD. Do I understand that they expect to have a staff of no more than 20 or 25? It is not to be a huge organization, but primarily one that will give direction in the military areas so far as space and related programs are concerned?

General SCHRIEVER. I think if they stick to that, in other words, a relatively small staff—I would not want to say whether 20 or 30 is the right number—but if they stay small and have high quality people they are certain to do a constructive job.

Mr. FORD. In the bill it provides that on this board of 17 there shall be at least 1 who shall be from the Department of Defense.

Do you think there should be a legal requirement that there should be more than one from the Department of Defense?

General SCHRIEVER. My feeling here would be that probably more would be better because this agency will have to draw on the military for much of its resources, if only to avoid costly duplication.

I think this is absolutely essential. One out of seventeen seems hardly enough. I don't know what the right number should be, but I feel it should be more than one.

Mr. FORD. Should it be one from the military side of the Department of Defense, or from the civilian side of the Department of Defense?

General SCHRIEVER. I believe they should come from the military side. Certainly if all three services are carrying on the programs which very likely will be carried out to meet the requirements of the total Defense Department, it would probably be well to have representatives from each of the services.

Mr. FORD. I have one final question. Is the Thor program on schedule at the present time?

General SCHRIEVER. It is on schedule and our program calls for having a squadron overseas in England by the end of this year.

Mr. FORD. The test that was conducted last week, was that an adverse one?

Let me put it this way: Was it one that indicates that you are still on schedule, or are you going to get behind schedule?

General SCHRIEVER. In the test Saturday we had an engine failure right after takeoff. The missile lifted off a few feet. However, the malfunction was one of those random failures that we run into occasionally—one of those incidents arising from the search for greater reliability. It was our first such failure in the whole program, and it was the first missile that we have lost at the launch pad during the last 9 or 10 firings.

As a matter of fact, we have had very good engine operations overall, although we have problems, as you might expect. We do have a problem in the engine right now, but it is not fundamental.

Mr. FORD. Thank you very much.

The CHAIRMAN. General, following Mr. Ford's line of questioning, the bill provides for at least one representative from the Defense Department. Of course, that could mean more than one. That is for the President to decide. The President is also Commander in Chief.

General SCHRIEVER. Right.

The CHAIRMAN. Assuming the committee should increase the number on the Board and provide a specific number, instead of specifying each service, have you an opinion as to whether the recommendation should be made from the Defense level by the Secretary of Defense?

General SCHRIEVER. I would say that the Secretary of Defense ought to be the one.

The CHAIMAN. There has been a lot of discussion, general, concerning this. You can see there is a lot of discussion about this among members. Other witnesses have been asked questions that you and others do not have the benefit of. There is considerable thought among the members of the committee, if I grasp their minds, and I am expressing my own, too, that in addition to whatever Defense Department representatives might be on this Board of 17, it would be very well from a workable angle to provide in the bill the establishment of a liaison group between this new agency and Defense on the working level where things can be brought up quickly, where things meet, where they can discuss and decide and get quick action. It would not be one of those groups that meet occasionally, but would be constantly available.

What would be your thought on that?

General SCHRIEVER. You mean a permanent staff?

The CHAIRMAN. Exactly?

General SCHRIEVER. I would say that our relationship with the Atomic Energy Commission through the Military Applications Office, which has been headed in every instance by a military man assigned to the AEC, has worked very well.

I would think that machinery of that kind would be required.

The CHAIRMAN. It is a question of getting men together.

General SCHRIEVER. That is right.

Mr. KEATING. And that machinery would be the best way of coordinating the military with the civilian activity?

General SCHRIEVER. In my organization out on the west coast, I have a large segment of the Strategic Air Command right there with me—a part of the Strategic Air Command Headquarters.

The same is true of the Air Materiel Command.

Ditto for the Training Command.

The fact that we are working together in the same location permits us to understand each other, to resolve quickly problems that need to be resolved. There is always a need for some compromise among operational, technical, and logistic factors.

You can do this best by living together and working together, and you can do it faster.

I am all for this sort of approach.

Mr. KEATING. Would you think it desirable that we establish this in the legislation, or leave it to executive action?

General SCHRIEVER. I think you ought to put it in the law, sir.

Mr. KEATING. You were asked also about the inclusion of more than one military representative among the 17 Board members. There has been some representation to us that it would be desirable to have one each from the Army, Navy, and Air Force. Nobody mentioned the Marines.

Now, do you not feel that if we increase the one and have the additional members named by the Secretary of Defense, it would be more nearly in line with the thinking of the reorganization plan which was presented to Congress recently?

General SCHRIEVER. I would think that you should leave it up to the Secretary of Defense to name or appoint the members of this Board.

Mr. KEATING. I want to refer to the question posed by the gentleman from California, Mr. Sisk.

As I envisage this proposed legislation, it is very much more than a simple upgrading of NACA. It is the creation of a completely new agency into which the present functions of NACA will be absorbed.

I do not think we should be confused by the similarity in names and the change from NACA to NASA.

For instance, under section 6, subsection (3), of this bill, among the functions of the new agency it is proposed:

> That they may develop, test, launch, and operate aeronautical and space vehicles.

There is nothing of that nature in the present functions of the NACA, is there?

General SCHRIEVER. They do operate aircraft, for example, at Langley Field and at Moffett Field in California.

Mr. KEATING. They actually operate them?

General SCHRIEVVC. Yes.

Mr. KEATING. Do they acquire, construct, improve, repair, operate, and maintain laboratories, research and testing sites and facilities? Do they do that?

General SCHRIEVER. Yes; they do.

Mr. KEATING. Of course, the next one is manned and unmanned aeronautical and space vehicles. They, of course, do not operate any space vehicles?

General SCHRIEVER. No, but they do operate aircraft and they have missiles and testing grounds and, of course, all the laboratories are under NACA direction.

Mr. KEATING. I thought the implication in it, which may not have been intended by the question put by the gentleman from California, was that this legislation represented, more or less, business as usual. Do you not think that the enactment of legislation of this, or similar character, would be a very important step forward in space development?

General SCHRIEVER. I think it would place greater emphasis on it, greater recognition from a national and organizational viewpoint. It would then be clear that the responsibility would be centralized in one agency, one is outside the military, and I think its real effectiveness would be determined by the kind of people that could be attracted to the organization.

Mr. KEATING. Unquestionably the naming of the Director would be extremely important here, as would the Board or Commission or however we may set it up.

General SCHRIEVER. That is right.

Mr. KEATING. Let me get back, however, for a moment to your answer to me about the present functions of NACA.

You said they operated aircraft, for instance. They do not directly contract for the construction of aircraft, do they?

General SCHRIEVER. No; they do not. They will occasionally enter jointly with the Air Force or the Navy in a program for experimental aircraft. They are in the X–15 program, for example.

The NACA is one partner in that project.

Mr. KEATING. In that project, for instance, they have contracted directly?

General SCHRIEVER. I would have to check this because I have not been involved in this recently, but I am quite certain that the contract is either a Navy contract or an Air Force contract, with the NACA as a full participant. They do not, I believe, contract directly with industry for the procurement of airplanes.

Mr. KEATING. They are given authority under this, as worded, to do that?

General SCHRIEVER. This bill is worded differently.

Now, at present when we turn the airplanes over to NACA for research and experimental purposes, they belong to the NACA to operate and do with as they please.

Mr. KEATING. The point I am getting at is that this is a very fundamental extension of their present authority.

General SCHRIEVER. That is right; it would be.

Mr. KEATING. You spoke of the failure of an engine the other day which as you have pointed out, was a failure after a number of successful launchings.

Is there any doubt in your mind that the Russians have had plenty of failures in their launchings?

General SCHRIEVER. Failures are part of the business. If they have not had failures they must be 50 feet high.

Mr. KEATING. You do not consider they are 50 feet high?

General SCHRIEVER. I don't consider they are 50 feet high.

I am sure they've had failures. It is just part of this business of development.

Mr. KEATING. As I understand it, your intelligence is that when they launched an ICBM it had a payload equivalent to a conventional warhead for that type of weapon. Is that what you are telling us?

General SCHRIEVER. I think I had better not get into that.

Mr. KEATING. The reason for the answer that you gave to the gentleman from Pennsylvania in saying that the recent launching at Cape Canaveral was not an ICBM launching was because your payload was not necessarily of such weight? Am I correct?

General SCHRIEVER. This is substantially correct. Yes, sir.

Mr. KEATING. When do you normally have the results of those tests? Is it a matter of 2 or 3 days, or is it more?

General SCHRIEVER. Determining the final results takes longer than that. Usually we get a detailed technical evaluation report after about 2 weeks, but after the third day, approximately, we do have a pretty thorough evaluation of the data. By then we at least know if we have had trouble; we have isolated the trouble and we know what it is.

We may not know at this particular stage precisely what caused the trouble—that takes further analysis. However, we will know the results of the test in terms of overall performance. If everything works right in our telemetering and with the ground equipment that is measuring velocities at burnout and so forth, we often know within an hour or so whether the missile has performed in accordance with what was planned.

But sometimes a telemetering channel goes out, or else one of our ground tracking stations goes out at the wrong time and we don't get the velocity at burnout. In that case it takes us longer to correlate the great quantity of data that comes in from down range stations with that collected at the launch base. We have, of course, both optical and telemetering data.

This is the reason it is sometimes hard to give a quick answer on a particular launching. I am not trying to avoid answering questions here this morning about yesterday's flight, but I just cannot tell you at the moment whether we got from it all the performance that we wanted.

Mr. KEATING. Would you know in 3 days, if you were ever going to know, whether the missile had returned to the earth's surface at about the point you anticipated?

General SCHRIEVER. Yes; we should know by then.

Mr. KEATING. Do you look upon outer space as simply an extension of atmosphere, as an area different in kind from the atmosphere immediately above us here?

General SCHRIEVER. I think it is quite different.

Mr. KEATING. There have been two suggestions made to us, namely, that outer space as compared to the atmosphere immediately above the earth is rather like the sea with varying degrees of density that is one concept.

The other is that it is more like the difference between land and sea. Where do you think the fact lies, or is it somewhere in between?

General SCHRIEVER. I have not tried to draw a line of distinction in quite that way. From my viewpoint, as a military man, I have looked at space in this way: From a technological and biological standpoint, and from an operational mission point of view, to go from the higher atmosphere in which the Air Force now operates into outer space is quite a natural and normal transition.

I do not mean to suggest that I am thereby claiming all of the missions in space for the Air Force. But a man who operates at

60,000 feet in an airplane is in a region that is on the threshhold of space.

He is then in an environment that comes pretty close to space environment and many of the problems biologically that you would have to lick for him are the same kind of problems you must lick for a man who is to go completely outside the atmosphere.

Mr. KEATING. You get up to a point where your equipment is no longer air breathing equipment?

General SCHRIEVER. That is right.

Mr. KEATING. Something around 60,000 feet?

General SCHRIEVER. That is true. One of our biggest development problems is that to conquer space we are going to have to develop a means of propulsion which will have long endurance and can operate in space.

Our present chemical powerplants are not suited for that purpose, but open to us now are a number of different approaches—nuclear rockets, ion rockets, solar rockets. I expect we shall try them all in our search for an engine that will operate in space for extended periods.

Mr. KEATING. What is the practical likelihood that we can, in the future, transport men and materials in capsules, like we would shoot a missile, more economically than we can fly them through the air from one place to another?

General SCHRIEVER. I believe this is entirely feasible and that it will come. I think that the first real practical use of space flight will be space flight within the earth's gravitational field.

In other words, you will take off from one point and land at another point on earth, using recovery techniques which still need to be developed. We can hardly afford to throw away an engine every time we do this.

But there are ways in which the problems can be solved. These developments will be coming along. I think we will be moving people and things through space and not have to contend with all the problems of moving at high speeds in the earth's atmosphere. The technical problems become very, very great when you move from twice the speed of sound to three times the speed of sound. When you encounter the material problems, heat problems, and so forth, you are really approaching the end of the line.

Mr. KEATING. When do you think I would be able to step into a capsule here in Washington and land in Europe in 30 minutes?

General SCHRIEVER. This is a hard prediction to make, but I see no reason why this should not be possible within the next 15 or 20 years.

Mr. KEATING. Well, that gives me time enough.

The CHAIRMAN. General, some of our missiles are based upon breathing, are they not?

General SCHRIEVER. Air breathing engines?

The CHAIRMAN. Yes.

General SCHRIEVER. Yes, sir?

The CHAIRMAN. How fast can they go?

General SCHRIEVER. The only intercontinental missile we have in this category is subsonic. It flies at less than the speed of sound.

The CHAIRMAN. How fast is that?

General SCHRIEVER. It is in the order of Mach .9, about 600 miles per hour.

The CHAIRMAN. From the military angle, what is the feasibility now?

General SCHRIEVER. Sir?

The CHAIRMAN. From the military angle, what would be the feasibility of that weapon now?

General SCHRIEVER. You mean its operational worth?

The CHAIRMAN. How effective would it be from the military angle?

General SCHRIEVER. This is a matter of judgment, sir. Certainly it is in the same category as our present bombers. I think that our bombers are perhaps a little more effective than the missile, because they have the man in them, because we can carry electronic countermeasures, things of that nature.

The CHAIRMAN. Do you have wing-flown missiles, too?

General SCHRIEVER. Yes, sir.

The CHAIRMAN. Are they pretty much of the same speed?

General SCHRIEVER. We have air defense wing flown missiles that are a little faster than that. The Bomarc flies at almost three times the speed of sound, which is 1,500 miles an hour, or thereabouts.

The CHAIRMAN. What will be the speed of the intercontinental ballistic missile when it is perfected?

General SCHRIEVER. The highest velocity it reaches at the time it enters the atmosphere is about 24 times the speed of sound—that is, about 15 to 16 thousand miles per hour.

The CHAIRMAN. Are there any further questions?

Mr. BROOKS. Mr. Chairman?

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. I would like to ask you this, General, before you get away: When was the atomic breakthrough?

General SCHRIEVER. Thermonuclear?

Mr. BROOKS. Yes.

General SCHRIEVER. There were two things that really happened that put a completely different light on the long-range ballistic missile.

First was the thermonuclear shot in the Pacific, the Mike shot. This was in 1952. That was the first thermonuclear explosion.

Of course, this was a device that weighed about 60,000 pounds, or in that order, certainly not something you could use in a ballistic missile.

But we fortunately had in the Scientific Advisory Board of the Air Force people like Dr. Teller, Dr. von Neumann. In 1953 we set up a panel and asked these experts and others to give us the best prediction they could with respect to the weight and yield relationship of the nuclear warhead out into the periods of 1959 and 1960.

This panel submitted to us a report in the summer of 1953. Among its members were Dr. Bradbury and Dr. York, for example. The panel predicted that we could get relatively high yields with very low weights in the 1959–60 time period. This prediction completely changed the picture regarding the ballistic missile, because from then on we could consider a relatively low weight package for payload purposes.

Mr. BROOKS. That is really one thing that held up the development of the intercontinental ballistic missile, but when the breakthrough occurred, did we take full advantage of that fact?

General SCHRIEVER. I think in retrospect you might say that perhaps we could have moved a little faster.

Actually, we got this prediction in the summer of 1953. Early in the fall of 1953 Mr. Gardner, who was then with the Air Force, set up a Strategic Missiles Evaluation Committee which reviewed all of the Air Force long-range missiles—not just ballistic. They recommended to the Air Force in February of 1954 that in view of this thermonuclear breakthrough, we should give the highest priority to the development of ballistic missiles and take advantage of the much lighter warhead then possible. This we did.

We picked up the program in March of 1954 and we have been pursuing it on the highest priority ever since.

Mr. BROOKS. It looks to me as though from your own statements, you wasted a year and a half before a decision was made to give this priority.

General SCHRIEVER. I am not sure whether you can call it wasting a year and a half. It takes time to get enlightened evaluation of such complex things. You could not simply take the word of one individual who would say, "Well, in 1960 we will have such and such."

You have to get more people who are also qualified to study these things. There were a lot of people who did not agree with this prediction, plenty of them.

You have to have pretty solid foundation before you launch forward into a multibillion dollar program.

I think we moved reasonably fast, sir.

Mr. BROOKS. It seems to me, though, that if the breakthrough occurred in 1952, and here it is 1958 before we have really taken advantage of it, we have been a little bit tardy about it.

But let me ask you this in reference to the missile that you fired yesterday. Was that capable of carrying an atomic weapon?

General SCHRIEVER. I think I had better not answer that for security reasons.

Mr. BROOKS. Use your judgment if you think it involves classified information.

The CHAIRMAN. We do not want any classified information.

General SCHRIEVER. I am afraid I should not answer that, sir.

Mr. BROOKS. Let me ask you this question. The Russians have fired the ICBM, but actually have we fired more ICBM's than the Russians?

General SCHRIEVER. At least with respect to firings which they have announced we have, yes, but as you know, our Atlas firings to date have been with the boosters only, so they have been at limited range. We will initiate long-range firings this year with the Atlas.

Mr. BROOKS. Of course, the Russians have a regular setup there, a range and all. They must have failed in some of their endeavors, otherwise it would not be necessary to have a setup like they have in Russia. Is that not right?

General SCHRIEVER. That is right.

Mr. BROOKS. What is the average cost of a missile like the one you fired yesterday?

General SCHRIEVER. It is hard to put an exact price tag on it during the development program, but I will give you essentially what they will cost when they go into operational force.

A Thor will cost slightly less than a million dollars each. That is the type that was fired yesterday.

Mr. BROOKS. That simply is in the construction of the missile itself?

General SCHRIEVER. That is right.

Mr. BROOKS. That is after you deduct all the expenses in connection with scientific experimentation and developing?

General SCHRIEVER. I have deducted the cost of constructing the research and development facilities and the cost associated with carrying on the research and development program. I am talking now about the production of the missile and the cost of all of the equipment that goes into it.

It would be a little less than a million dollars when the missiles are introduced into the force.

Mr. BROOKS. That is about the same for the satellite missile, is it not, or is that more expensive?

General SCHRIEVER. Which satellite?

Mr. BROOKS. Let us say Jupiter-C.

General SCHRIEVER. The Jupiter-C, of course, is a research and development article and the Jupiter-C, if you produced in quantity, would cost less than that. The Jupiter itself is essentially the same as the Thor. They are in the same price category.

Mr. BROOKS. So you have gotten out of the experimental stage with the type of missile you used yesterday. Is that a fair statement?

General SCHRIEVER. It is still in the development program.

Mr. BROOKS. It is in the manufacturing stage now, is it not?

General SCHRIEVER. It is being produced on what we call hard tooling; yes. We are not hand-building it. We have the necessary tooling and we are building it on a production line.

Mr. BROOKS. That is fine.

Now, I have one more question. I want to ask you this.

The administration bill provides for a 17 member committee with not less than 1 person from the military. Now, a great many of our witnesses, perhaps most of them, have been connected with the military either directly or indirectly, like Dr. von Braun. He would be military.

General SCHRIEVER. Right.

Mr. BROOKS. Do you not think we might very well place in the bill a stipulation that the first board shall consist of not less, we will say, than 50 per cent military personnel, because the program has been military in the past—let us face it—and then following that there shall be, we will say, not less than 1 military person?

General SCHRIEVER. This is a matter of judgment. My reaction would be that that would not be right. I think that would be too many.

Mr. BROOKS. What would you think would be the right number?

I do not think any member of the committee wants, even by inference, to exclude men like Dr. von Braun if it is in the cards for him to serve on the Board. But if we do not watch out, we may be excluding men that have carried this program right on through to this

hour. Maybe they want to get out later on, but for the time being, unless we have men that have gone along with the program in sufficient supply, the Board will founder for a long time initially. Do you agree on that?

General SCHRIEVER. I agree, but I think a figure of 3 to 5 men, if carefully selected, and they certainly would be, would be adequate.

Mr. BROOKS. Your idea is 3 to 5 men from the Government?

General SCHRIEVER. Yes.

Mr. BROOKS. They might not necessarily be military men, they might be civilian men, but they would come from the United States Government or largely from the Defense Department.

General SCHRIEVER. My 3 to 5 men would be from the Defense Department. I would say that you ought to have at least 2 or 3 in uniform in that group.

Mr. BROOKS. I would think you would want 1 or 2 perhaps from the Weather Bureau because that is important.

General SCHRIEVER. I am not excluding other Government agencies. I have referred only to the Department of Defense.

Mr. BROOKS. If we wished to acquire someone else from other departments, it would have to be in addition to them?

General SCHRIEVER. Yes, sir.

Mr. BROOKS. That is all.

The CHAIRMAN. Could you not depend upon the President to use judgment in making these appointments?

General SCHRIEVER. I think so. I think you could.

But you asked my opinion, and I think that is how many from the Defense Department should be on the Board. I think it is extremely important in the initial phases that there be adequate representation from the military because right now the Defense Department has the only program that exists in the space business.

Mr. BROOKS. My point was that we did not want to write into the bill something that gave the impression that we did not expect more than one man from the military.

That is all.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. General, the proposed legislation calls for a 17-man Board that is to meet no less than 4 times a year. This Board is an Advisory Board. As the name itself indicates, an advisory board is created for the purpose of advising.

Now, liaison committee, or a liaison group, is established for the purpose of coordinating, that is, to let the right hand know what the left hand is doing. That leads to this question:

Would you say there is a sharp line of distinction or delineation between the two types of functions, one, concerning an advisory board whose primary function is to advise and two, a liaison board whose primary function is to coordinate? Would you agree with that conclusion?

General SCHRIEVER. That is essentially correct; yes, sir.

Mr. FELDMAN. So that a board which would meet no less than 4 times a year or even 10 times a year would not be in constant touch with the developments going on or the problems arising in connection with the new agency and the military. Is that not correct?

Let us put it another way. Assuming you had 3 or 5 or 7 members from the military on an advisory board that met 6 times a year, would

they be able to perform adequately the liaison functions that go on in the every-day work between two groups that are supposed to be working in cooperation with each other?

General SCHRIEVER. I would doubt that they could perform it adequately. In the first place, they would be at too high a level in the military to do what you are talking about.

Mr. FELDMAN. An advisory board, even if it had more power than the particular Advisory Board proposed in the new legislation, could do no more than set policy. Is that right? That is what it is created for when it is on that kind of high level, is that not so?

General SCHRIEVER. That is generally correct; yes.

Mr. FELDMAN. And the every-day problems that come up between two agencies could only be handled properly by a liaison group which would have some means of constant coordination?

General SCHRIEVER. I'd judge that is the most effective way.

Mr. FELDMAN. That, to my mind, is the only way that the right hand can know what the left hand is doing.

General SCHRIEVER. That is the most effective way I know of to do it.

Mr. FELDMAN. In other words, you pointed out earlier in your testimony, in response to a question by Congressman Natcher, that the military must carry out its portion of the program.

General SCHRIEVER. Yes.

Mr. FELDMAN. And the way they can do that best, of course, is through close liaison with any new agency?

General SCHRIEVER. Yes.

Mr. FELDMAN. Krafft Ehricke, who was a witness here yesterday, as Congressman Fulton stated before, said that Russia was too far north for a good moon shot. What are your views concerning the location of our base in Florida?

General SCHRIEVER. Our base in Florida is so situated geographically that it can accommodate a moon shot.

Mr. FELDMAN. Do you have any comments in connection with Mr. Ehricke's observation?

General SCHRIEVER. No; I will have to look into that. That is the first time I have heard that statement made. I do not understand why it should be, but that intrigues me. I shall have to look into it. I hope he is right.

Mr. FELDMAN. So do we.

Astronautically, when is the moon in a good position for a moon shot?

General SCHRIEVER. I cannot give you that detail, but it happens over a period of about 3 or 4 days each month as far as our location down south is concerned. I do not have the astronomical details, but that is the case.

The limiting reason is, of course, the ability to make an observation as to whether you have accomplished what you are after.

You could shoot at the moon any time, but you might not be in a position to see whether you made it. It is observing what happens at the other end that is important.

Mr. FELDMAN. Early in your testimony you spoke of a conference you had with some scientists and you mentioned Dr. Killian and several others who, prior to this proposal concerning the NACA or the NASA, had mentioned the need for an agency with a singleness of purpose

to explore and work in outer space. You said that you were in agreement with this point of view.

General SCHRIEVER. I made that statement. It was not a conference. It was an informal meeting at which we were discussing certain problems concerning organization, looking into the future. I was in agreement that all of the development, research and exploration into space should not be left in the hands of the military alone.

In my opinion, you need a scientific group that pushes forward on the broad frontiers of knowledge as well. I want to make it real clear that I believe very, very strongly that the military must not be inhibited in carrying out their own program.

Mr. FELDMAN. I will not attempt to speak for this committee, but I know the chairman previously indicated that that was one of the things the committee had uppermost in their minds.

However, at the time of this informal discussion, did not the scientists have in mind concentrating on the development of a program that would deal with outer space?

General SCHRIEVER. Yes; during that discussion there was absolutely no inference that this agency should be the single agency to do all of the space work. The general point was the need for a scientific approach to the space problem. The discussion is largely scientific in nature.

Mr. FELDMAN. There is so much overlapping anyway between both the civilian and the military that there would have to be the kind of coordination you are talking about.

General SCHRIEVER. That is right.

Mr. FELDMAN. And the kind of emphasis?

General SCHRIEVER. Right.

Mr. FELDMAN. But it was the purpose of these scientists to concentrate on outer space problems. Is that right?

General SCHRIEVER. Largely from the scientific point of view, and to undertake things that might look screwball in nature, or that the military cannot undertake—things that are real researchy in the sense that if the military did them we would be criticized. We might not even think of them, maybe.

Mr. FELDMAN. Do you think that the kind of group thinking of the present NACA setup, at least as evidenced here, would carry out a program of that kind? Because Dr. Dryden characterized a lot of these ideas as circus shots and things of that sort, and was very wary of even thinking along those lines.

General SCHRIEVER. Words are hard taskmasters. There certainly are things that you should not do.

Let me speak of my experience with NACA. I attended Stanford University and took graduate work there just before the war. Some of the finest students from Stanford in the aeronautics field went to the NACA at Moffett Field. They stayed there for a good many years.

Only recently a couple of them left to go back as professors at Stanford University. I have found that NACA has a lot of forward-looking, imaginative people.

Mr. FELDMAN. Among their 7,500 or 8,000 employees I am sure they have many that are very forward looking, but I just wondered whether thinking in terms of aerodynamics, as distinguished from astronautics——

General SCHRIEVER. I think you have to get some new blood, say astronautics blood, into the organization, certainly.

Mr. FELDMAN. And that these scientists had in mind concentrating on that field at this informal conference you are talking about?

General SCHRIEVER. Yes.

Mr. FELDMAN. Do you think that an agency such as the NACA that has been primarily concerned with aerodynamics can suddenly switch over to thinking in terms of astronautics? It is a question of emphasis now.

General SCHRIEVER. Yes, I do. I think you have to organize in a fashion. I ran into the same problems in reorganizing my staff. If I subordinate, say, the space vehicle part to the Atlas program, I am not going to get the emphasis I want on the space vehicle.

I have organized in such a fashion that a separate element in my organization spends all their energies on the problems of space vehicles as distinct from those of the ballistic missiles.

Talking now philosophically, I think you can approach the organization problem in the same way within the NACA.

Mr. FELDMAN. Are you building on a block as you put it before, or should you start with a fresh point of view?

General SCHRIEVER. It is a matter of judgment. My own judgment is that you should use the NACA as the building block.

Mr. FELDMAN. Earlier, you were asked your views about the proposal that Dr. von Braun made here that a man be sent into space in a rocket, going up 150 miles in a capsule and returning to earth. It was also mentioned that Dr. Dryden characterized that kind of experiment as similar to a woman being shot from a cannon at a circus.

That was kind of lifted out of its context a little bit, because General Medaris pointed out that you have to crawl before you walk and that there was a great deal of scientific value to such an experiment or there could be.

I think it would be unfair to Dr. Dryden to give a curbstone opinion under those circumstances, and also to, at the same time, have him characterize the program as one that was circus-like. It was equally unfair, of course, to Von Braun, because I am sure, when he gave that testimony, he was thinking in the same terms that General Medaris was and knew a great deal more than just the fact that we wanted to get a man up into space in time for the purpose of putting on an exhibit.

Do you have any views on that?

General SCHRIEVER. I think there is no question but that you could get a lot of data from such a flight.

At the same time, I would not want to say that this experiment is one that I would propose. There are a number of proposals for getting man into space. I know that ARPA is considering these proposals and that undoubtedly a sensible program will be gotten underway.

As a matter of fact, certain things in programs now underway will contribute toward this end. Also, you certainly cannot overlook the psychological and political aspects of perhaps getting someone up in space, even if it does come close to appearing to be an exhibition rather than a scientific event.

I would not go along 100 percent with what Dr. Dryden said, and I am sure he did not quite mean that 100 percent the way it has been taken.

Mr. McDONOUGH. Speaking on that particular subject about shooting a man into space 150 miles, first, has that been a serious subject for discussion under your command?

General SCHRIEVER. Not that type of experiment.

Mr. McDONOUGH. The X 15 is, I suppose?

General SCHRIEVER. The X 15 is, although the X 15 is not directly under my supervision. We have developed a complete step-by-step program for getting man into space on a phase basis involving recovery capsules, animals, and so forth. We think this systematic, long-range approach makes a lot of sense, and we hope to get some approval for.

Mr. McDONOUGH. Certainly, shooting a man 150 miles into the air and returning him is not a stunt, by any means. You have the reentry problem, you have the ability of the man to stay under pressure in the takeoff, his condition up there, coming back, and his landing.

It is not a stunt, in my opinion, at all.

Do you have any volunteers who are willing to go on such a flight?

General SCHRIEVER. I am sure that there are plenty of volunteers. We have gotten quite a few letters from volunteers.

Mr. BROOKS. I will say that I have gotten a letter, myself.

Mr. KEATING. They told me at Canaveral that they had 13 or 14 from the Army. I bet they got just as many as that from the Air Force.

Mr. McDONOUGH. Seriously, do you have men that you can say would be willing to go if we were ready to shoot one in 30 days?

General SCHRIEVER. We have heard from a number of people volunteering to be the first man in space. I got one letter from an Australian recently and it was a very sensible letter. He was a young man who was volunteering. It was a very well written letter. He was not a crackpot.

Mr. McDONOUGH. Whether it be a capsule or powered vehicle, we have a man who is willing to fly the X 15 and we know him.

General SCHRIEVER. That is right.

Mr. McDONOUGH. How far has Pied Piper progressed?

General SCHRIEVER. This is a highly classified program, sir. I would say that it is progressing well. It is now on a high priority, that is, on a priority equal to that of the ballistic missiles.

Mr. McDONOUGH. It is being designed for power flight?

General SCHRIEVER. No, sir. This will be a satellite.

Mr. McDONOUGH. It would just travel on an orbit?

General SCHRIEVER. Yes, sir.

Mr. McDONOUGH. And be capable of reentry?

General SCHRIEVER. Not necessarily. But we are very interested in the reentry of capsules. It is part of our development work.

Mr. BROOKS (presiding). Mr. Metcalf.

Mr. METCALF. I was interested in your designation of some of the research as screwball. I hope you will clarify that a little bit because I think you meant it in somewhat the same sense that Dr. Dryden meant, this business of shooting a man into space as a stunt. That

would be the basic research for which there would be no immediate military or civilian value, would it not?

General SCHRIEVER. My reference here was to research that might look screwball to some people. That does not necessarily make it screwball.

Mr. METCALF. Would you call something like a proposal for photon propulsion screwball?

General SCHRIEVER. No, I certainly would not.

Mr. METCALF. In your experience, has there been some actual military or civilian value derived from research that looked very strange in the past?

General SCHRIEVER. I think you have me there. I cannot quote any examples, but we do carry out basic research programs in which large funds are not at stake and which do not have immediate military application, although they are directed toward a possibly useful military application.

In other words, if we are successful in this type of research, it can lead to worthwhile military application. I believe we should have people carrying out research who have no thought about the military whatsoever.

Mr. METCALF. People who probably have not gone through the same sort of program as the military, so they are not thinking along the same lines as you.

General SCHRIEVER. That is right, a military man does go through a regime that is quite different from a scientist.

Mr. METCALF. All these research agencies under the proposed legislation would be under the NASA. Would you not feel that that is the way it would be set up?

General SCHRIEVER. Yes, although I think it should be clear that we in the military do a lot of research and development and experimental work which is necessary for the actual development of the weapons themselves. We would continue to do certain research and development work as we now do in the airplane field.

Mr. METCALF. Where, in such a system, would be a lunar probe? Would it remain under ARPA, would it go to the new NASA or would it be purely military?

General SCHRIEVER. I would say that if the agency already were in existence the lunar probe might well be undertaken by that Agency. That Agency would still have to draw upon our equipment and our resources and, therefore, as was pointed out earlier, there would have to be the closest liaison between it and the military.

Mr. METCALF. I think it has been developed by Mr. Feldman that no matter what happens to the composition of the board there has to be daily, constant, and continuous liaison between the civilian and the military agencies.

General SCHRIEVER. I think so.

Mr. METCALF. Would you just let ARPA continue on this project for a lunar probe, or would you transfer that over to the new agency?

General SCHRIEVER. I would leave it where it is.

Mr. METCALF. And just incorporate that within it?

General SCHRIEVER. I mean that any time you start transferring things in midstream, you just have a built-in delay. That is all there is to it.

Mr. METCALF. I think that is all.

Mr. FELDMAN. I have 1 or 2 last questions, General Schriever.

In the development of the missile and satellites and the whole program regarding outer space, there will be a great deal of contracting work where there will be a shift in emphasis from, say, aerodynamics, to hardware that will travel in outer space.

General SCHRIEVER. As I take it in the proposed legislation, this would be the case.

Mr. FELDMAN. Is it not the case, too, in the present program of the military?

General SCHRIEVER. You mean our emphasis in this direction?

Mr. FELDMAN. Yes.

General SCHRIEVEV. Yes, there has been.

Mr. FELDMAN. A lot of engineering into new contracts?

General SCHRIEVER. Yes.

Mr. FELDMAN. That is a changeover from one type of industry to another type of industry. Is that right?

General SCHRIEVER. That is not right. When we held our contractor-selection competitions for our present ballistic missiles and satellite programs, it turned out that the companies which had been engaged in aircraft weapon development were among the most competent companies in the country for undertaking this new work.

Mr. FELDMAN. But during the changeover there was an interim period when you had to kind of let down on the emphasis of making aircraft and things of that sort and going into this new field. Is that right?

General SCHRIEVER. I do not think we have let down the emphasis.

Mr. FELDMAN. Was there not a dislocation caused by the shift, which caused a certain amount of unemployment, say, in the main plant and various other plants? Is that right?

General SCHRIEVER. This is correct, but you cannot pinpoint space——

Mr. FELDMAN. I am not finding fault; I am just pointing out the fact that we are going through a transitional change.

General SCHRIEVER. That is true because missiles, particularly in the air defense field, have developed to a point where they are beginning to dislocate the aircraft industry in the fighter-interceptor area, for example.

Mr. FELDMAN. After the development stage in missilery, and when we get into the making of hardware for missilery and satellites and space ships and so on, the unemployment caused by this dislocation, that slack, will be taken up again. Is that not so?

General SCHRIEVER. If you measure total labor requirements on the basis of the dollars required for the program, this is certainly true, because I do not foresee that the sums required to carry out these new programs will be less than for those of the past.

Mr. FELDMAN. While at the present time we may have some unemployment partially caused by this dislocation, when this program gets into full swing would it, in your opinion, absorb most of the people that were previously engaged in the aircraft industry and who are unemployed at the moment and who will be again reemployed in this new field?

General SCHRIEVER. I think, numberwise, this is probably correct, but I certainly would not want to say that it would be true in every specific location or company.

Mr. FELDMAN. It certainly would be a trend, to say the least.

General SCHRIEVER. I think so; yes.

Mr. FELDMAN. We might even get to a point where we will have a shortage of labor in 3 or 4 years.

General SCHRIEVER. I might cite one example. Lockheed has put their missile division in the San Francisco area. There is a labor shortage there, of the kind of people they need.

Mr. FELDMAN. I am trying to bring out the fact that the impact of this new program on our economy can be a great one and can absorb a great deal of unemployment.

General SCHRIEVER. Yes; we have in our ballistic missile program alone—in our prime contractor plants and in our first-tier subcontractors—about 80,000 employees.

Mr. FELDMAN. Can you give us an idea of what it was 3 years ago?

General SCHRIEVER. Three and a half years ago we only had two contractors, North American and Convair, and a few minor subcontractors. I don't think we had over 5,000 people.

Mr. FELDMAN. In other words, it is multiplied geometrically rather than arithmetically?

General SCHRIEVER. Of course, the work is spread out throughout the country, too. We have a number of contractors on the east coast, and in the Middle West.

Mr. McDONOUGH. Will the gentleman yield at that point?

Mr. FELDMAN. Yes.

Mr. McDONOUGH. Are these contractors you are speaking about engaged in the production of hardware or development and research?

General SCHRIEVER. Development and production.

Mr. McDONOUGH. And, between the two, which field are most people employed in?

General SCHRIEVER. Up until recently, we have emphasized the engineering and development phase of the program, but these same contractors are continuing into the production phase of the program.

Mr. McDONOUGH. Up to what point do you call in the contractor? Are you producing anything at all?

General SCHRIEVER. You mean as a Government agency?

Mr. McDONOUGH. Yes.

General SCHRIEVER. No, sir.

Mr. McDONOUGH. You are merely asking for proposals and submitting specifications to be met.

General SCHRIEVER. That is right, but that is a continuous process in these programs. Of course, we do provide a lot of the facilities for the testing by which we evaluate developments as they progress.

Mr. McDONOUGH. Is there any testing being made by private industry, independent of the military, on these matters?

General SCHRIEVER. In the missile area?

Mr. McDONOUGH. Yes, missile or astronautics?

General SCHRIEVER. There is some research and experimental work being done within some laboratories on their own. This is always true in major development programs, but does not involve large-scale and expensive testing. Such testing is all done under Government contract.

Mr. McDONOUGH. Is the Point Mugu base under your command?

General SCHRIEVER. No, Point Mugu is the Pacific missile test range. It is under the control of the Navy and under direct Navy command, but it is a joint range.

These facilities are available to us, although we don't use them. We have no missile for which it is suitable, but the range will support our firings from Cooke Air Force Base.

We are not putting up a separate facility for firings we will do from California.

Mr. McDONOUGH. In other words, there will be no duplication?

General SCHRIEVER. No duplication. They will support us in these firings.

Mr. McDONOUGH. Is there a reduction in duplication in actual testing, for instance, between Cape Canaveral, Point Mugu, and Edwards Air Force Base and those places?

General SCHRIEVER. Canaveral is the only instrumented, long range that we have in being today.

All three services use Canaveral, and they use the same instrumentation. For example, at the time that the Air Force and Army initiated Thor and Jupiter programs, we coordinated with the Army and Patrick to establish the instrumentation requirements for our test programs.

So I would say that Cape Canaveral, although it is under Air Force management, is a Department of Defense range.

Mr. McDONOUGH. And the duplication of testing is reduced to a minimum; an effort is being made to reduce it to a minimum?

General SCHRIEVER. Duplication of testing?

Mr. McDONOUGH. You are not going to test a missile at Mugu that you could test at Canaveral?

General SCHRIEVER. No. We will not be testing missiles on the Pacific range.

The actual firing of missiles at Cooke Air Force Base, for example, will be for training and for operational suitability testing, not for development testing. Development testing will all be done at Cape Canaveral.

Mr. McDONOUGH. What I am getting at is this. When we set up a budget here we do not want to have an expenditure of several million dollars in 2 places when it can be done in 1 place.

General SCHRIEVER. This is very closely watched at the Department of Defense level to insure complete coordination between the military departments regarding range utilization.

Mr. McDONOUGH. As a military commander engaged in the defense of this Nation, what is your opinion as to entering into some agreement with other nations to establish outer space, that is beyond the thousand-mile level, as a peace area, rather than a military area?

General SCHRIEVER. I think if this could be accomplished, it would be very good.

Mr. McDONOUGH. Do you conceive it to be in the same position as where we look upon the ocean as an open highway for all nations, but at the same time we must protect our interests on that highway at all times?

General SCHRIEVER. That is the way I look at it, yes.

Mr. McDONOUGH. You mean, if we did enter into an international agreement with other nations, especially with the one that

seems most capable of attacking us in that area, Russia, that it would be with the understanding while it is for peaceful purposes, nevertheless, we will protect our interests in that area at all times?

General SCHRIEVER. As a practical man I think this is what we have to do.

Mr. McDONOUGH. That is all.

Mr. BROOKS. Mr. Fulton?

Mr. FULTON. General, I would like to ask you about your ideas as to the method of industrial development of this new space or guided missile industry.

When the contractors are large contractors making agreements for overall projects, does that let every type of business take a part in the contracting with the military procurement agency, or does the subcontracting go down pretty deep through the ordinary people that that particular contractor has used previously?

How wide a spread are you getting, both in types of business as well as area cooperation and participation in the expansion of this industrial field?

General SCHRIEVER. I do not have exact figures.

Mr. FULTON. Will you put them in the record at this point.

General SCHRIEVER. Yes; I would rather do it that way, sir.

Mr. FULTON. Thank you.

(The material referred to follows:)

AIR FORCE BALLISTIC MISSILE DIVISION CONTRACTING PROCEDURES

One basic factor must be appreciated in any analysis of industrial development and diversification in the Air Force ballistic-missile program. That factor is the overriding urgency of the program, which has necessitated selection of the best qualified contractors in the country, both managerially and technically, in order to insure development and production within compressed time schedules for the complex systems and components required. No new industry has resulted; in fact, there could not have been time to create a new industrial base.

Development and production of major ballistic-missile subsystems has required extension of the technical state of the art in the structures, propulsion, and electronic portion of the aviation industry. For all intents and purposes, the strongest capabilities for this extension and expansion have been found within existing defense industry. Major contractors have been selected from the industry listing and data long maintained at Headquarters, Air Materiel Command.

The major contractors' make-and-buy structures—which determines the extent of subcontracting—are carefully reviewed by Air Force representatives as part of our contract negotiation, and maximum subcontracting is encouraged. Some of the factors by which these make-and-buy structures are judged are availability of in-being facilities and required technical personnel, distressed labor areas, startup cost, unit cost, etc.

The resultant contractor structure of the Air Force ballistic-missile program includes 18 major contractors, some 250 subcontractors, and thousands of suppliers—all widely dispersed, geographically, across the Nation. Through calendar year 1957, $268.3 million, or about 21 percent, of ballistic-missile business has been subcontracted to small business by major contractors in the program. A small-business representative has been appointed within the Ballistic Missile Office of AMC, the office in our Inglewood complex which is responsible for industrial contract administration. As an example, the Douglas Co. is currently utilizing 8,473 small-business concerns as subcontractors in producing the Thor missile.

With the advent of Sputnik I and II, security classification has been relaxed to some degree, allowing wider dissemination of our programs to industry and the Nation in general. All participating prime contractors have been instructed to provide information on their respective programs to companies desiring to participate, providing they have been given security clearance and have a need

to know. Procedures have been established for providing the required security clearance. In addition, speeches are frequently made to industrial groups by military representatives of the ballistic-missile programs, and our headquarters is visited monthly by dozens of prospective contractors.

Mr. FULTON. Some of us are interested in developing this field because we think this is the equivalent of the start of the automobile, the telephone, the telegraph, or the airplane industry. We feel that it is a bright, new field for industry and, if more companies knew about it, there would be a tremendously accelerated interest and pace in development. Do you not agree, sir?

General SCHRIEVER. I think most industry does know about this, because we certainly are getting a tremendous amount of interest and requests from industries throughout the country to enter into certain aspects of the program.

Mr. FULTON. My judgment is, and I said it to the General Counsel this morning, that most industry does not know about it. In the fields in which you and the Air Force have been dealing with, I think that is true, but, out in the general area of basic industry and fabricating industry, they do not know what is going on in this particular field.

General SCHRIEVER. This is industry that has not worked for the military departments previously?

Mr. FULTON. Yes.

General SCHRIEVER. I think you are probably right, Mr. Fulton.

Mr. FULTON. I have suggested to the General Counsel that we, in this committee, have mobilization of industry meetings, have a separate space and guided-missile section and program. Would you agree on that? There are now regional meetings being held, with the War College participating, on organizing industry for what might be the next trouble.

Do you not think there should be added emphasis on the space field in that particular program?

General SCHRIEVER. Yes. I would think anything that would stimulate industry and the people more and give them more knowledge would certainly be a step in the right direction.

Mr. FULTON. Do you think it would be wise for the Government to explain, possibly through the Department of Commerce, to the people some of the testimony that we have had before this committee, so that the industries, themselves, will know what the developments are and can aim in that direction?

General SCHRIEVER. I think that would be a good idea; yes, sir.

Mr. FULTON. Do you likewise feel that there is need for an authoritative governmental overall glossary and dictionary of the scientific terms in the space and missile field? Should we have an agency set up that will take part in this program on the basis of coming up with all the services, all the Government agencies and contractors, and getting a terminology that is authoritative?

General SCHRIEVER. I think this would be helpful.

Mr. FULTON. As you know, the Air Force has its glossary of March 1958, but that is the Air Force's glossary, and is not an official terminology so far as the overall United States Government is concerned. So that we do need a broader dictionary or glossary, do we not?

General SCHRIEVER. I think this would be helpful. This is something I had not thought about, myself.

Mr. FULTON. With respect to the translation of materials from foreign countries, do you not think it would be advisable, under some sort of agency or department in the Library of Congress, possibly the Legislative Reference Service—we have a very prominent member, Dr. Charles Sheldon, on this consulting staff of ours—to have a program of getting an overall translating service on a broad scale of the many facets of basic research and development in the applied-science field on space technology?

General SCHRIEVER. I am not too familiar with the translation activity that is going on, although it has come to my attention from time to time that, perhaps, it is not quite as adequate as it should be.

Mr. FULTON. When that translation is made, there should be adequate facilities made available by the Government so that they will be ready for use by the various services and by the companies in the field?

General SCHRIEVER. Yes.

Mr. FULTON. For example, it has been said that small companies cannot get hold of the research programs because they have not had previous contracts. Nor can they get the information on certain technical developments, because they have not been previously in the contracting field with a particular service. So, what happens is this: When they are not able to get the information ahead of time, they are automatically excluded from participating. Do you think that should be cured?

General SCHRIEVER. I do not believe that is entirely correct. It is correct that companies who are not participating in a program do not have clearance, securitywise, to receive classified information about that program.

Mr. FULTON. That is my point. First, you do not have the clearance, so you do not get the classified information because you are not participating in the program. That is the reason you cannot participate in it, because you do not know about it ahead of time. So, it automatically restricts it to the people who are, primarily, participating in the program.

General SCHRIEVER. The people who are already participating in it have certain advantages. There is no question about that. The fact that they are already participating and have an organization and have experience and background——

Mr. FULTON. How do we broaden it so that other, smaller companies can now participate? Could they possibly, be cleared ahead of time so that they can get access to classified information that will let them know what is going on?

General SCHRIEVER. This is a very difficult problem. You could go too far in one direction and give information to everybody. The security problem is one that I do not quite have the answer to.

Mr. BROOKS. Will the gentleman yield at that point?

Mr. FULTON. Yes.

Mr. BROOKS. Last week, at my home, there was a meeting, an industrial meeting, held by the Small Business Administration. The Air Force was well represented at that meeting. So was the Army, and so were some other branches of the services. The question of bids on contracts and offerings and all that sort of thing was covered pretty well. There might have been more emphasis placed on ballistic missiles and aerodynamics, and things of that sort. Would you agree to that?

General SCHRIEVER. I am sure there probably was.

I would also say, however, that in the contractor selection competition, no company is automatically excluded just because it does not happen to have a security clearance or are not participating in the program.

Mr. BROOKS. The point I am getting to is this: that these small-business men should be invited to these types of meetings. When they are invited, they should be given the means whereby they can contact the proper Government officials and get proper notice and opportunity to present their offers, if they wish to do so.

General SCHRIEVER. I think there is a great deal of potential for small business through contracts directly with the Government in the research and development area.

I certainly agree with you, Mr. Fulton. It would be highly desirable if we could find the right platform.

Mr. BROOKS. Would you agree with me, too, that there might be more emphasis placed on these industrial meetings?

General SCHRIEVER. Yes.

Mr. FULTON. That was my original suggestion. He agrees with both of us.

May we finish on that?

Here is one practical result and there is no complaint because these are high-type businessmen.

The small-business man finds that he learns of something being done, often at Cape Canaveral, after the fact.

There is a small business of medium size in Pittsburgh that had the design for the type of structure, steel structure, that encloses the missile. It found, after the fact had occurred, that somebody, through another contractor, had simply ordered the installation from the West at a great cost of freight on the same design that the Pittsburgh company had developed and worked out at its own expense, but had not patented.

The Pittsburgh company had been given no opportunity to bid on its own item and it was brought 3,000 miles across the country to Cape Canaveral with no notice to the Pittsburgh company.

Now, how do medium-size companies get into the program and get the chance to bid through your prime contractors?

Is it not working now so that the prime contractor gets the contract and he then deals on a commercial basis with whomever he wishes.

General SCHRIEVER. No, I certainly do not think that is true. These people are not directly under my control, though.

Mr. FULTON. I agree on that.

General SCHRIEVER. We have Air Force plant representatives at our major contractors. They very closely screen and scrutinize the subcontracting activity of each of these major contractors.

Mr. FULTON. May I just finish with this?

May I have the head of the Small Business Administration contact you and work out with you a program that can be recommended to this committee by a joint statement of the two of you as to how small business and medium-size businesses should best participate in the space and guided missile production program?

General SCHRIEVER. I will be very happy to have him come out and meet with both myself and General Funk, who is the air materiel command officer out there, who is responsible for all the contracting and

who is going to appear before the Senate Small Business Committee here next week, I think.

We shall be very happy for him to come out.

Mr. FULTON. Thank you.

We would like to have your legislative recommendations on this matter for the committee to put in its legislation.

May I close on one thing that you spoke of, and that was your worry about security. How did Reuters Agency in Britain have the story last weekend and that there was going to be a shot at Cape Canaveral Wednesday, yesterday, of this week, when this committee knew nothing about it?

I checked with several witnesses here that were in a position to know and they did not know about the schedule, and yet, through some leak, Reuters, a foreign news agency, knew about it.

Now, will you please explain that to me through the proper Air Force channels because I mighty well would like to know.

I wanted to go see the shot with other Congressmen and I did not know about it. Yet I could read of it through Reuters.

General SCHRIEVER. I do not know, myself.

Mr. FULTON. Will you please supply that for the record.

General SCHRIEVER. I can assure you I was extremely upset by this story. I do not know where it came from.

Of course the fact that we have a launching scheduled down there is known in the proper channels within the Air Force and Department of Defense. Where a leak might occur it is hard to say.

Mr. FULTON. It was not one of those authoritative sources often quoted in Moscow, was it, that gave the information out to Reuters?

General SCHRIEVER. Not from my organization.

Mr. FULTON. I would not imagine so but, I am just asking you about your security. If it disturbs you very much on that story, how do you think it disturbs Congressmen when we want to see the shot and cannot get anybody to say the shot is going to take place.

I wanted to go down and see it, but I could not get anybody to calendar it for me within a week. I should have believed Reuters of London, I guess.

General SCHRIEVER. Well, this was classified information. In executive session I would have been very happy to give it to you.

Mr. FULTON. How, then, did Reuters get it? I think that should be answered for the records of our committee.

Mr. KEATING. Mr. Chairman, will you yield for a question or two?

They have been having one of these national researchers conferences in my city of Rochester in the last 2 weeks. In opening, they pointed out the very purpose of it was to acquaint the business manufacturers in that general area about new military developments.

Now, they would cover space and such matters in it, insofar as it was unclassified.

General SCHRIEVER. Yes.

Mr. KEATING. You made the statement that 3½ years ago there were roughly 5,000 people engaged in this program and today there are 80,000.

I realize these are rough figures. What do you look for 3½ years from now, again in rough figures?

General SCHRIEVER. If we are talking about the Air Force program alone——

Mr. KEATING. Were you talking about the Air Force program?

General SCHRIEVER. Yes. I would say that there certainly will be some increase, although we have built up very fast and there has been a leveling off in the last 12 months.

I would think that we might increase by another 50 percent.

Mr. KEATING. I assume that a comparable development has taken place and will take place in the other services or perhaps you are not familiar with that.

In general, would that be true?

General SCHRIEVER. This would be difficult for me to say. Do you mean that in the overall missile field there certainly has been and will continue to be an upward trend?

The Army is engaged in its antiballistic missile defense program and in its Pershing missile program; the Navy is active with its Polaris and its air defense missiles programs. These are all on the upward curve in terms of manpower required in industry.

Mr. KEATING. That, so far as you can foresee, will continue in the next month and probably the next few years?

General SCHREIVER. I would say that that trend will continue up for some time.

Mr. KEATING. That is all.

Mr. BROOKS (presiding). Let me ask you this now. In response to the question that Mr. Fulton asked you, would it be possible for you to advise the counsel of our committee the next time there will be a shot by the Air Force at Cape Canaveral so that we can get word to Mr. Fulton and other members who might wish to go?

General SCHRIEVER. Let me try to give you the answer directly. We can give you classified information as to when the next shot will be.

Mr. BROOKS. You can give it to counsel. I was watching an atomic test at one time. I spent a week there and I think the test is yet to go off. It never did go off.

Now, we might run into the same thing, but if members want to go down there and see a missile go aloft and you can do it without violating security, and it seems to me you can, why they should have an opportunity.

General SCHRIEVER. I agree with this.

Mr. BROOKS. I know the general well enough to know he will be glad to cooperate with the committee.

General SCHRIEVER. We have had Members of Congress there, and we are very happy to have you come down, as a matter of fact.

Mr. BROOKS. We are anxious especially to get Mr. Fulton down there. But, the gentleman had better consult counsel before he goes down again.

Mr. FULTON. I will.

Mr. KEATING. May I make a comment before we adjourn. I have been very much impressed with your testimony, General. The same goes for the other representatives of our armed services that have appeared before us.

I wish every American citizen could hear the testimony of gentlemen like you and Admiral Rickover and the others who have told us about this picture, because I feel that it would instill great confidence in the minds of the people and those in responsible positions in our services would have this great problem before them.

I compliment you and I extend the same to the other services that have appeared here. I have been very delighted with the real vigor that you are putting into this program, all of you.

Mr. BROOKS. I am glad Mr. Keating mentioned that because I consider General Schriever a very able officer and I like the way he testified.

Mr. FULTON. I want to say this. How many echelons of decision do you have to go through to get a firm decision on a test?

My criticism at Cape Canaveral was that you could not find who was really going to make the decision on the first test. It did not seem to be there.

Nobody at the local installation seemed to know when it was going off, even within 12 hours before the next countdown started.

How many echelons above you do you have to go through to get a firm decision on a major missile shot?

General SCHRIEVER. None. We make the decisions right within our headquarters.

Mr. FULTON. Has that been the way all along?

General SCHRIEVER. Yes, sir.

Mr. FULTON. How did the Air Force get the first instruction to make shots? Is it just an overall instruction or did they tell you to go ahead on this missile or that missile?

General SCHRIEVER. When we obtain approval to proceed with the development program of a specific missile such as the Atlas or Thor, the actual implementation of that program is then left up to the Air Force. In my particular case I have a very great authority with respect to the management of the programs. The scheduling of tests is based strictly on technical considerations.

When the missile is ready to go, it goes.

Mr. FULTON. I want to congratulate you on your testimony and the Air Force on its progress in the space and missile field and also to say that I do not believe that that was the fact when the Navy was first shooting off the Vanguard.

They did not have at the scientific level the power of firm decision, as to the timing and the method of shot.

General SCHRIEVER. That may be true. For example, when I go down to Patrick I do not run the show down there. The organization is set up and the people that are responsible for the test carry on. I am down there observing.

Mr. BROOKS. General, when you receive authority to make the shot, what are the controlling elements in the delay? For instance, Mr. Fulton was there waiting for that shot. He apparently thought it was going off rather slowly, but you have to move quickly, I can see that, in this business.

What are the controlling, last-minute considerations?

General SCHRIEVER. They are usually technical in nature. We go through quite a long countdown and we check everything before these research and development shots.

Delays are becoming less and less frequent now. As a matter of fact, on the last several shots of the Atlas we have gone through the countdown and pushed the button right on the second.

Mr. BROOKS. I mean, what will stop your countdown? Would it be a change in the weather, a change in wind variance, or something of that sort?

General SCHRIEVER. No, not for our missiles, no. We have no problem on the weather.

Mr. BROOKS. What is it?

General SCHRIEVER. It is usually a technical difficulty. Maybe a telemetering channel goes out, or maybe the range safety radar goes out. Or perhaps we discover a leak in our fuel system somewhere, or in our liquid oxygen system.

Mr. BROOKS. You are not controlled though by last-minute cables from Washington, are you?

General SCHRIEVER. Absolutely not.

Mr. BROOKS. And there are no considerations other than——

General SCHRIEVER. The people who are conducting the test have the responsibility for making the decision as we go along.

Mr. FULTON. You hit a very pertinent point. Suppose you had a liquid oxygen valve that had failed three times, as it did with the Vanguard at Cape Canaveral, and then you were repairing the valve, say the third time, and the decision comes from Washington for you to go ahead with the shot. You know that this particular type of valve has been leaking each time you started your countdown. Would you then go ahead with the shot as ordered, because that is what the Vanguard people had to do?

General SCHRIEVER. If I were directed by higher authority, which I have never been, I would go ahead with it, but I would certainly state that it was against my better judgment.

Mr. FULTON. Thank you.

Mr. BROOKS. Now, if you got outside direction to stop or to send that missile up, it might actually be very dangerous, if you sent a missile up with a mechanical difficulty; is that not true?

General SCHRIEVER. Well, there are certain conditions under which it could be dangerous—not to life—but dangerous to equipment. I think these are hypothetical cases so far as my program is concerned anyway.

Mr. BROOKS. We want to develop these things to the fullest extent. Now, if your missile is in difficulty mechanically, a leak, for instance, then the take off, you say, is not dangerous to property or life at all?

General SCHRIEVER. If there was something mechanically wrong with the missile, it would not be fired.

Mr. BROOKS. Even if you got the word from Washington to fire it?

General SCHRIEVER. That is right.

Mr. BROOKS. You would not fire it?

General SCHRIEVER. I would not fire it.

Mr. BROOKS. So you have real control of the situation down there. If Washington had some reason for holding up the firing and sent you word, there would be no reason for not holding it up, would there?

General SCHRIEVER. If I got the direction not to launch, I would not launch—certainly not.

Mr. BROOKS. Because there is no danger at all, but there might be danger in sending aloft a missile that has mechanical trouble.

General SCHRIEVER. If it was mechanical trouble, we certainly would not launch it, but in Mr. Fulton's example it was a question of judgment whether or not that particular valve would function properly after they had several failures. I am sure they went through the countdown and did not have a failure of the valve, or they would not have fired. I am sure of that.

Mr. BROOKS. Mr. Feldman.

Mr. FELDMAN. I want to make an observation. You pointed out just now that you are finding less and less difficulty as you fire these various missiles.

In other words, you are in this development stage and what you are actually doing is getting the bugs out of the system. Would you summarize it that way?

General SCHRIEVER. This is certainly one of the most important aspects of a development program.

Mr. FELDMAN. That is why you are doing the firings, to get the bugs out of the system?

General SCHRIEVER. That is right.

Mr. FELDMAN. And in that way to perfect the missile ultimately?

General SCHRIEVER. That is right.

Mr. FELDMAN. After you do that, then you will put them into production, into mass production?

General SCHRIEVER. That is right.

Mr. FELDMAN. At least, that is contemplated?

General SCHRIEVER. That is right.

Mr. BROOKS. And you are making substantial progress in that direction?

General SCHRIEVER. We have made substantial progress in our ability to say we are going to fire a missile on a particular day and have it go. Actually, we carry out what we call a static firing on a missile at Patrick prior to the launch. Sometimes we run into problems on the static firing which will then delay the actual launch. But once we have gone through the static firing, our prediction of the day and the hour at which we are going to launch is usually quite good.

Mr. BROOKS. Are there any further questions? If not, the committee will adjourn until 2:30 this afternoon.

(Whereupon, at 12:55 p. m., the committee recessed to reconvene at 2:30 p. m., the same day.)

AFTERNOON SESSION

The CHAIRMAN. The committee will come to order.

The next witness, and we are very happy to have him before us, is Maj. Gen. J. P. Daley, Director of Special Weapons in the Office of Chief of Research and Development of the United States Army.

We are glad to have you with us, General. You may proceed.

STATEMENT OF MAJ. GEN. J. P. DALEY,[19] DIRECTOR, SPECIAL WEAPONS, OFFICE OF CHIEF OF RESEARCH AND DEVELOPMENT, UNITED STATES ARMY; ACCOMPANIED BY LT. COL. ROLAND V. TIEDE, CHIEF, BALLISTIC MISSILES BRANCH, OCRD UNITED STATES ARMY

General DALEY. Mr. Chairman, before making my formal statement, I would like to introduce Lieutenant Colonel Tiede, from the Office of the Chief of Research and Development, who is accompanying me.

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I am, as you said, Maj. Gen. John P. Daley, the Director of Special Weapons, Office of Chief of Research and Development of the Department of the Army. Within Research and Development, I have the staff responsibility for Army missile and space program. As a background for my appearance here before this committee I reviewed the tasks which face the committee. Excerpted briefly from your chairman's opening remarks—they are, and I quote, "to conduct a thorough and complete study and investigation with respect to all aspects and problems relating to the exploration of outer space," and further, "to enact effective legislation to meet this problem."

This is a momentous task. I am sure you gentlemen realize completely that the work of this committee will be reflected in the history books of coming generations. The exploration of space is just beginning. It will continue for centuries. The point I wish to make is that we should not seek a 1-year solution or a 2-year solution. We must seek a firm foundation for what I believe will be a continuing and an increasing program for the exploration of space.

I have asked myself what can I contribute to the work of this committee and it is in that frame of reference that I make these subsequent remarks. I intend to speak briefly on the military significance of space to the Army; turn briefly to the Army's contribution to present and near future space programs; and close with a few remarks with respect to the proposed National Aeronautics and Space Agency.

First, then, the military significance of space to the Army. Why is the Army interested? From the military point of view, there do not appear to be any applications of satellites and space vehicles that are unique to the Army, to the Navy, or to the Air Force.

Instead, such applications appear to be applicable to all three services. The immediate possible applications for satellites include reconnaissance and surveillance, both visual and electronic; communications of all kinds; meteorology; mapping and geodesy, to include navigation; radar targets for use in development and training in anti-intercontinental ballistic missiles systems and as space laboratories for conducting military research. All of these are national military requirements. Each of the services has resources to contribute to the achievement of these objectives.

The Army strongly supports a national integrated space program which makes use of national assets, military or civilian, to achieve national objectives, military or civilian.

The Army's interest in space has already resulted in a demonstrated capability to contribute to a national space program. The contributions of the Army to the satellite program are well known to you. Beyond these, as has been announced by the Secretary of Defense, the Army Ballistic Missile Agency has been directed by the Advanced Research Projects Agency to launch 2, and possibly 3, earth satellites and 2 lunar probes.

These latter will attempt to place instrumented payloads in the vicinity of the moon. Beyond this short-range program, the Army can make significant contributions to a long-range program for the conquest of space. The establishment of United States supremacy in space can be achieved only by carrying out a long-range national integrated program which assigns responsibility for a complete phase

of the program to competent teams such as the Army Ballistic Missile Agency and the Jet Propulsion Laboratory.

It is expected that such an assignment will be made by the Advanced Research Projects Agency, which, of course, has the task of preparing an integrated Department of Defense program.

The establishment of a National Aeronautics and Space Agency, based on the National Advisory Committee for Aeronautics, is a desirable move since it creates a national agency to deal with a national program and since it gives this new national Agency an existing framework on which to build.

On the other hand, it must be recognized that this new Agency must lean heavily on the Department of Defense for some years to come in order to carry out satellite and space experiments.

We can move into space in the immediate future only by using existing hardware or hardware that is well along in development.

Almost all of that hardware is military hardware.

I foresee no big problems of establishing effective cooperation between the National Aeronautics and Space Agency and the Department of Defense, particularly since the Department of Defense responsibility is centered in the Advanced Research Projects Agency.

In conclusion, gentlemen, the Army supports a national, not a service, space program; the Army can and wants to contribute its proven resources to such a national program; lastly, the Army welcomes creation of an agency which will insure that our national program meets civilian as well as military requirements.

Mr. Chairman, that completes my opening statement.

The CHAIMAN. Mr. O'Brien?

Mr. O'BRIEN. I have no questions at this time, Mr. Chairman.

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. General, according to the provisions of the bill that we have before us at this time, this new Agency would be a civilian-controlled agency. Have you had a chance to examine the bill?

General DALEY. I have examined the bill, I think fairly carefully, sir.

Mr. NATCHER. How do you feel about the Agency being a civilian-controlled agency?

General DALEY. I believe that it should be a civilian-controlled agency, because the terms of reference for this Agency extend not in particular to military space programs, but provide particularly for the Nation's move into space.

While many of the things that have been mentioned to this group I know have had military implications, certainly there are vast civilian implications in this move into space, the most obvious one, of course—and Dr. York is a far better witness on this subject than I am—is the advantage from a purely scientific standpoint.

But beyond this, you are looking generations ahead and man's ability to move out into space must mean a great many more things than purely military. So I say I think it should be a civilian agency.

Mr. NATCHER. General, another provision of the bill provides that the Board shall consist of not exceeding 17 members. How do you feel about that particular number? Do you feel that is too many, not enough, or just how do you feel, General?

General DALEY. I examined that wording rather carefully and I believe I have looked into the history. I believe it actually comes, or it seems to me that it derives, from the National Advisory Committee on Aeronautics. That is probably the reason for the 17. The bill says not to exceed 17 members. As a general philosophy, and I am not a legislator, in giving a man a mission to do, I believe you should set the boundaries but not the details, and when it says not to exceed 17, I assume that this is a reasonable number, and that if 17 is too many, it will be whittled away over the years to come.

I have no strong feeling that this is too many or too few.

Mr. NATCHER. Another provision is to the effect that 8, or not to exceed 9, will be from the different agencies of the Government, with 1 to be designated by the Secretary of Defense.

The CHAIRMAN. At least one.

Mr. NATCHER. At least one.

How do you feel about that particular provision, General?

General DALEY. Having put myself in my own philosophy, practically in the hole, I believe that at least one should be from the Department of Defense; in other words, I believe that there should be some representation from the military departments.

I can well visualize that more than one might well be put on this Board. But whether or not it is a wise thing to write into legislation, I don't know. As a matter of fact, we find, going back to the National Advisory Committee on Aeronautics, that they spelled it out very carefully in that, the representation from the Department of Defense.

It did not foresee the creation of the Air Force and the separation of the Air Force from the Army, and the fact that the Army members went with that left the Army without representation. Sometimes spelling these things out can be worse than not spelling them out.

Mr. NATCHER. The Director of this Agency, under the bill, is to be named by the President and confirmed by the Senate. What qualifications, in your opinion, General, should the Director of this particular Agency have? Should he be a scientist? Should he be a man with experience in private enterprise, a fine administrator?

Just what type of qualification should this director, in your opinion, have?

General DALEY. I believe first of all, and this may be a narrow viewpoint, this man must have great executive ability, or great administrative ability. You are giving him a task to run an organization and he has to be able to run an organization.

Beyond this, if not a scientist, certainly a man who has appreciation for scientists and a man who has some background to give him that appreciation.

I say if not, possibly a scientist. I know scientists who are fine administrators, and I know scientists who are not fine administrators.

I would say these are two of the key things. The third one is two moral characteristics, perhaps: A man of vision, whatever this connotes to you, a man who is not tied to what he sees right in front of him, but who can look beyond.

And certainly a man with some enthusiasm, some ability to draw people to him, some ability to tell the people of the United States what is being done and why it is being done, and to lead us. These are the characteristics I would look for.

Mr. NATCHER. General, I want to thank you for the fine statement you have made to our committee.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. General Daley, in setting up a priority, if you will permit me to put it this way, of the needs that exist right now for the most expeditious action in this program, can you put a priority on a list of that kind?

In other words, what, today, do you consider to be the greatest need in order to move ahead with the program that we are contemplating?

Is it the type of agency that we are proposing to set up here, or is it something else? I realize this is a rather broad question.

General DALEY. I am trying to really consider it so I don't give you a hasty answer. I would say that in looking at the long-range viewpoint, the most important thing is to settle on, No. 1, an organization. This one will do it on the national scale. The Advanced Research Projects Agency does it within the Department of Defense. To settle on an organization or individuals who can be held responsible for where you go, I think, is a primary requisite. Having settled on those organizations, then I think it is the integration of a national program in which you must get the advice of these agencies, of these individuals who are responsible, to set long-range goals and work toward those goals.

I have a fear that, in the middle of October, we get wildly excited because there is a sputnik in the sky. It is not that we shouldn't, but we go up to a peak of excitement and we drop down. We need to set a goal that we are willing to work for, which the scientists agree is a good one, which the Department of Defense agree is a good one, something that you gentlemen, as representatives of the people, believe you can support, not just this year, but next year and the next year. This, to me, is a second prerequisite.

Mr. SISK. In other words, the setting up of a centralized authority which will have control and direction of a national, overall program.

General DALEY. These are the things that I think will help you. This will not solve the problem of where you are in July, but it may solve the problem of where you are in July of 1963.

Mr. SISK. What are your present connections or relations with NACA?

General DALEY. My direct relations? I have none. The Army does have representation on some of the boards or committees of the NACA. The Army does not have representation at the top level in the NACA, although I believe that there is a bill that would give the Army such representation.

Mr. SISK. Why have you not had representation on the NACA?

General DALEY. This, I think, is merely historical. When the NACA was established, back in 1915, that provided for representatives from the War Department then, I suppose, and the Department of the Navy. When the Air Force was set up, after World War II, the Army representatives, quite naturally, went with the Air Force. This left the Army, itself, without representatives. Since Army aviation has grown considerably since World War II, there has been, I believe, a bill presented to add Army members to it.

Mr. SISK. So, at the present time, the Army, as such, is not represented in the making of policy decisions or in anywise directing the overall program?

General DALEY. Not at the top level, sir.

Mr. SISK. You mentioned, I believe, in an answer to a question from the gentleman from Kentucky, that you felt that NACA could be the vehicle around which the new Agency could be established. To what extent is NACA failing to do the job that we need to have done today? Is it lack of authority?

General DALEY. I am a poor judge of that. As a matter of fact, all that I know is that the National Advisory Committee for Aeronautics, from anything that I have heard, has a fine reputation, sir.

But it is for aeronautics, and its relations, naturally, have been chiefly with Air Force and Navy, as far as the Defense Department goes. Its dealings, and this, I think, is within the history of the growth of it, naturally, have been mostly with the air industry.

These are things that it properly should be doing under its present charter. I say I am a poor witness, but, as far as I know, it is doing a good job. This bill takes that organization and gives it an entirely new area. It adds to it the space area of research exploration, if you will. When you do that, you can't simply take the National Advisory Committee for Aeronautics and its suborganizations and say, "This is the end-all."

In my opinion, you must broaden its contracts; you must broaden its contracts militarily and broaden its contracts civilianwise. You will, undoubtedly, have a change the internal organization, add certain types of individuals to it. But it does mean that, instead of sitting here and setting up an organization and starting in that from scratch, by naming a director, getting a stenographer, and going through the ramifications, you take an organization which has, at least, worked in part of this field, and which gives you a working structure. To me, this is a great advantage. In the Army, we cadre a unit, send a few individuals, and build a unit around it. This is the same thing.

Mr. SISK. Do you anticipate, then, that ARPA, as an organization in the Department of Defense, would continue, and that liaison would exist between ARPA and the new proposed organization?

General DALEY. I would be afraid to say "No" with Dr. York sitting this close to me, sir. But, actually, yes, sir. To me, there is a need for the Advanced Research Projects Agency in the Department of Defense; there are many of these things that are military, and there should be somebody that draws together the military programs and integrates these military programs.

The Advanced Research Projects Agency, so far as I am concerned, is set up to do that, and it is very important that it does that. At least for the next few years, the new National Aeronautics and Space Agency will have to depend a great deal on the Department of Defense, simply because we have the vehicles.

I think that Dr. York, Mr. Johnson, the head of ARPA, these gentlemen should pull together the defense capabilities and the defense needs, and that a natural point of contact is ARPA to NACA.

Mr. SISK. Pursuing that a little further, then, would you anticipate that there would be two contemporary organizations, or would you anticipate that this new Agency would actually be the top agency,

having certain authority over ARPA, or vice versa? I am curious to know to what extent and to what relationship the two organizations might fit in the picture, as you might anticipate it. What we may do, I have no idea yet.

General DALEY. I would believe that it would, largely, be a cooperative thing between these two agencies, although I think that, if there were a conflict between the Department of Defense, as represented by ARPA and this new National Space Agency, I am sure this would go right to the top levels of the Government. I would hope that it would be a cooperative enterprise, much like the Atomic Energy Commission deals with the Department of Defense in these matters.

The bill says that this Agency will exercise control over research, except insofar as activities peculiar to or primarily associated with weapons systems. In this field, then, there must be a play back and forth. I don't think you can say that this new Agency would be completely over all of the things that ARPA would control, directly or indirectly, or, otherwise, you are going to get a problem of at what point you take a space program and decide what is the conflict with the weapons program.

I think that ARPA must at least speak for the Department of Defense in this respect, or the Department of Defense speak for itself.

Mr. SISK. Of course, you could visualize some conflict when it comes to a determination, let us say, as to just what the military application of a given program might be. There might be differences of opinion. I can certainly see where, I think, that could be worked out.

General DALEY. I agree; there will be differences of opinion. There are differences of opinion between the Atomic Energy Commission and the Department of Defense, but 999 of them get argued out before they go above the departmental level.

Mr. SISK. I have one other question, General. In view of some comments, and some of the things you read from time to time, there has been some criticism of the fact that one of the reasons we have not made the most complete utilization of our scientific and engineering know-how in this country has been the fact that, in many cases, these scientists have been restricted. They have been kept under wraps, have not had a free rein, let us say, to dream and then to try to put their dreams into reality. Just how free do you anticipate we might be able to make these men who, actually, are going to come up with the ideas which ultimately will put us into space?

General DALEY. This is a very difficult problem. Actually, we have people that are allowed to, if you will, dream or think of the future. We have them in the Army Ballistic Missiles Agency. There is always the problem, quite frankly, of how much of your funds you put into this, and how much you put into hardware. I am sure that almost any of the scientists that are in this advanced reaching-forward area would say that we don't put enough effort in here.

This is just a matter of judgment. I am sure that, many times, the people that have to make these decisions, including myself, can be quite wrong and don't put enough effort in this field. I do not see why, though, you cannot give scientists, under these terms of reference, or within the Government, latitude to explore things. But, eventually, you come up to the point of how much money you will back that with. I don't know whether this is a very satisfactory answer or not, but probably not.

Mr. Sisk. I appreciate your thinking on it. The time comes, of course, where, if their dream is to be utilized, you have to have some hardware to back it up and do experimental work. Then, of course, is when the big money becomes involved. It becomes a matter of how much you are going to risk on a given idea. I appreciate that.

That is all, Mr. Chairman.

The Chairman. General, this bill provides for the head being a Director. What are your views for a commission form of agency?

General Daley. I would like to preface my remarks by saying that I get along fine with the Atomic Energy Commission, but perhaps that is from my military background. I like to know that one man is responsible. My reaction is that I prefer a Director rather than a group of individuals.

The Chairman. Have you any views as to whether we should go right across the board in research and development, of course having regard for the military—because no one can disregard what you people have said about the position of the military in the world of today and in the foreseeable future—right across the board with the establishment of a Department of Science with Cabinet status?

General Daley. Conceivably this, in the long future, looking years ahead, might come to pass some day. It is my opinion, personal opinion, that it should not be given Cabinet status at this time.

It is not the same nature and of the same scope as the organizations which are now represented on the Cabinet.

The Chairman. I meant going across the whole board, bringing in all research activities, including existing agencies.

General Daley. No, sir. I do not believe Cabinet status is correct in this case, because I do not believe it would benefit this country to attempt to put all of the research and development that is done in this country into a single department of the Government or controlled by a single department of the Government.

It is too interlaced with many different departments of the Government. It is not only a case of Army, Navy, Air Force. It is a case of the Atomic Energy Commission; it is a case of many of our other departments having research and development projects. Furthermore, a great deal of research and development is done within civilian industry.

I simply believe that it would be a very loose organization. I am not sure what it would represent.

The Chairman. I am not arguing with you. I have no presupposed views. But aren't we rather loose now? We have several departments and agencies handling research.

General Daley. Yes, we do, sir. I think that this is just fine. I believe it is just fine, especially as you get toward the development and the applied research. This is done to meet the particular needs or the particular purposes of that established department. I think it is the best judge of where it should put its effort.

The Chairman. What about putting that Agency in with the Atomic Energy Commission, merging them, for example? I am not saying that is my opinion.

General Daley. I understand, sir, entirely. I have considered this Agency and the Atomic Energy Commission, just thinking about the problem. I believe that you have almost the other side of the

coin, when you are talking about this Agency and the Atomic Energy Commission, the Atomic Energy Commission—and I am speaking of it and its laboratories, the whole organization—was set up when there was no centralized research in this one field, when there were no laboratories, no facilities in this one field, and for purposes of national security it gathered to itself tremendous resources from the country and developed and built these things.

So the resources in the atomic energy field grew up under that Atomic Energy Comission or its predecessor.

In this particular case, the resources of this Government are already spread across the width and breadth of the land.

We have some of them. Huntsville, Ala., ABMA, is just one.

We have a team there. Navy has teams. Air Force has teams. Industry has teams in these things. In view of the difficulty of pulling these all together under a single Agency, I think we are starting now when a thing is widespread and it would not fit in under the Atomic Energy Commission.

Furthermore, to take that specific example, the Atomic Energy Commission, I think one of the strengths of the Atomic Energy Commission is the fact that it deals in a particular field with atomic energy.

I have had my arguments with them, but I like that general system. I think it would dilute the Atomic Energy Commission if you threw on it this additional burden.

Therefore, I, as an individual, would be opposed.

The CHAIRMAN. Can't you see that some time in the future we may have to do it, applying the law of natural and probable consequences, projecting that line into the not remote future?

General DALEY. It is true that the Atomic Energy Commission and the products of the Atomic Energy Commission——

The CHAIRMAN. I am talking about all across the board now. I recognize the military necessities, so don't get involved in that. I am talking about on the civilian side. Nobody recognizes the necessity of military strength, I think, more than I do. Others do as much as I do, but nobody more. If I am going to err, I am going to err on the side of strength rather than weakness. Eliminate the military side. That is not involved in my question. Projecting your mind into the future, can't you see some time in the future where the importance of this activity, research, and development, would be such that there would have to be a Department created with Cabinet status, particularly if the world's tension subsides, and the important emphasis on the military does not exist as it does today?

General DALEY. Yes, sir, I could foresee that this could be so, that there might be a Department growing up. I certainly don't want any of my remarks to be interpreted to say that I am anything but in favor of pushing our science and our technology.

I certainly feel that if such a Cabinet Department were created, this should be a very evolutionary process, and to do it right now would be precipitous.

The CHAIRMAN. To the contrary, General, your answers have been very frank, and I appreciate them. You have met every question any one of us have asked you directly. I certainly don't misunderstand where you stand.

General DALEY. Yes, sir.

The CHAIRMAN. We have a reorganization bill, I think, floating somewhere around the atmosphere of Washington. You have heard of it, have you not?

General DALEY. I have heard rumors, yes, sir.

The CHAIRMAN. Not getting into that from this angle, but I noticed that the reorganization bill provides that there shall be a Director of Defense Research and Engineering who shall be appointed from civilian life by the President.

You are acquainted with the provisions of the bill, so I will not read it.

General DALEY. Yes, sir, I am.

The CHAIRMAN. Would the language regarding the Director of Defense Research and Engineering, assuming that language is finally enacted into law, interfere with the establishment of an Agency along the lines of a bill which I have introduced for the administration?

General DALEY. Not in my opinion, sir.

The CHAIRMAN. I am inclined to agree with you. I wanted to get your opinion on the record.

General DALEY. I feel that the bill there created a Director of Research and Engineering within the Department of Defense, that individual authority lies entirely within the Department of Defense. There would be more conflict, and this is simply an internal resolution by the Secretary of Defense, there would be more chance of conflict between the Advanced Research Projects Agency and that Director of Research and Engineering than there would be with this outside Agency.

My personal opinion is that somebody should represent the Department of Defense in dealing with the outside and that this would not interfere with that.

The CHAIRMAN. As a passing observation, I introduced bills a few years ago providing for an Assistant Secretary for Research and Development at both the Defense Department level and in all the service departments.

No staggering progress was made, but we made a little.

General DALEY. Yes, sir.

The CHAIRMAN. What is your opinion, assuming that 17-man Board survives the ordeal of this committee—personally, if it was something new, I would not be impressed by it, but I realize the historical development that you referred to, I appreciate the historical background of it, and the factors that create—assuming the Board survives, remains in the bill, and is enacted into law, what is your opinion about provisions in the bill to establish a liaison group between this new Agency and the Defense Department, where they would be at a constant working level?

General DALEY. I am not sure that I would favor putting this into a bill at this time. I actually have tried to resolve in my own mind: How would you exchange information? How would this Space Agency place requirements on the Department of Defense or the Department of Defense explain its requirements to the Space Agency?

Today, between the Department of Defense and the Atomic Energy Commission, you have—and it is part of the law—a military liaison committee, which states to the Atomic Energy Commission Department of Defense requirements, which tells the Department of Defense what the Atomic Energy Commission capabilities are.

I could visualize growing up, possibly, something you might call the civilian liaison committee to the Department of Defense, which would actually be this Space Agency creating a group of individuals who kept constant contact with the Department of Defense. You have almost the reverse.

The Atomic Energy Commission today has the facilities in the atomic-energy field, and the Department of Defense is the man who asks. Here you would have the Department of Defense, which has most of the facilities, and the Space Agency is putting the requirements on. There would, I think, grow up some such liaison group.

I would be somewhat skeptical about putting it into law before you established these organizations and find out how they work. This liaison function might well be performed purely between the Director of the Advanced Research Projects Agency and the Director of the Space Agency.

But I could visualize very well some liaison group being set up to be sure that the Space Agency knew exactly what the capabilities of the Department of Defense were, and to insure a steady, constant flow of information both ways.

The CHAIRMAN. Would it not have importance from that angle?

General DALEY. There must be a complete, thorough exchange of information, sir. I am simply saying I don't like to prejudge whether there need be this liaison committee actually set up by law or not, whether there would have to be. I am sure that if you set the 2 agencies up, and there were nothing set up in the law, there would have to be established between those 2 agencies a system of liaison that was complete and thorough.

The CHAIRMAN. I would agree with you that anybody administratively probably would do that.

On the other hand, he might not do it. I was thinking more from the angle of the defense of our country, to insure that the means existed by which the views of the Defense Department would, as a matter of law, be expressed. The thought I had would strengthen its position. You know the Atomic Energy Commission originally started with emphasis on the military side. It was 1954 that the emphasis was changed, without putting the military in a secondary position, and properly so.

As far as I am personally concerned in any bill, I want civilian control, but I don't want the military placed in a subservient position.

Yet I recognize the difficulties that sometime exist in human relations. The thought I had was that this might be a strengthening influence from the military angle, and I am very much interested in that.

General DALEY. My feeling is that the provisions in the bill, as it is written, appear to provide sufficient protection for both the military and the civilian.

The CHAIRMAN. What provisions in the bill are there that provide that, except blanket administration?

General DALEY. Well, the provision in the bill that says that the civilian agency is over all, except insofar as weapons systems peculiar to the military; the provision in the bill on this National Aeronautics and Space Board that there shall be at least one member from the Department of Defense.

The CHAIRMAN. You have already said that you thought that should be increased or might be increased.

General DALEY. It might well be. I would think that there might be more than one. But the law says there will be at least one.

I simply am not sure that establishing, by law, at this time, before you have established the Agency, establishing this liaison change, is necessary.

I don't believe that the law that you pass can answer all things. This is a workable bill. This civilian liaison committee——

The CHAIRMAN. I hope it will be. It is a basis for consideration, certainly.

General DALEY. It is a basis for a workable bill, sir. It is just a question in my mind as to whether you should inject into this a specific liaison at this time or not.

The CHAIRMAN. You better get what you think is in there at the outset, because it would be much easier than trying to get it in later by amendments.

General DALEY. My personal recommendation right now is that you do not inject into this a civilian liaison or a military liaison committee. That is my personal recommendation.

The CHAIRMAN. All right, General. My inquiry was a little more than a philosophical inquiry, you understand.

General DALEY. Yes, sir.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. You do feel that there should be a liaison committee of some kind between the Department of Defense and the Space Agency, do you not?

General DALEY. I feel that there must be liaison, sir. Whether this is by a committee or by individuals is a question.

Mr. FULTON. Actually, whether they wear a uniform or not is not too important to you, is it?

General DALEY. No, sir. Frankly, in the liaison in this particular case, if it were set up, I would be more inclined to make it a civilian one from the Space Agency to the Department of Defense than a military one the opposite direction.

Mr. FULTON. But that is simply because the Department of Defense, in the first instance, has moved much further than the newly born Space Agency, so that you are saying that as a preliminary matter, not as a final judgment?

General DALEY. This is correct, sir. I am saying that on the basis of the state of affairs as exists today.

Mr. FULTON. Next, though, if it were developed that this Space Agency on civilian matters would have the same preeminent position that the various services under the Department of Defense have today, you would then be revising your thinking, would you not?

General DALEY. I certainly would, yes, sir.

Mr. FULTON. Then, in the language of the bill, on page 2—and we will look particularly at lines 7 and 8, although we will start at the beginning of the sentence on line 4—"The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States, except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in

which case the agency may"—and I point out the words may "act in cooperation with or on behalf of" and I point out the words on behalf of "the Department of Defense."

May I direct your attention to the fact that there may be a limit on the activities of ARPA if that agency is restricted to such activities as may be peculiar to or primarily associated with weapons systems or military operations.

Do you think that limit is too severe in this legislative language?

Do you think there is room for basic research?

General DALEY. I consider that a reasonable interpretation of these words should include basic research, or research that is certainly the type of research that goes on in our Ballistic Missile Agency today. If the language were interpreted otherwise, so as to completely exclude the agencies handled by ARPA from the research field entirely, I think this would be a mistake. I think it would result in drying up the talents of your teams.

It is fine to have a little bit of advanced hardware going along, and some practical hardware research, but my experience leads me to believe that the best way for one of these teams is that it also must have a chance to reach out into the future. This we do have down at the Army Ballistic Missile Agency, if this prohibits that, then I think it should be modified.

Mr. FULTON. Could you, in conjunction General, with Dr. York, submit at this point in the record in your statement a form of language which would insure that basic research would remain in ARPA, and that there would be leeway so that the possible jurisdictional disputes might not become basic hurdles for the Department of Defense? Could you submit that?

General DALEY. Yes, sir.

(The document referred to follows:)

DEPARTMENT OF THE ARMY,
OFFICE OF THE SECRETARY OF THE ARMY,
Washington D. C., May 26, 1958.

HON. JOHN W. MCCORMACK,
Chairman, Select Committee on
Astronautics and Space Exploration.
House of Representatives.

DEAR MR. CHAIRMAN: In accordance with your request during the appearance of Maj. Gen. John P. Daley before the Select Committee on Astronautics and Space Exploration on April 24, 1958, the following suggested rewording of lines 4 through 10, page 2 of the proposed act (H. R. 11881) is submitted:

"The Congress further declares that such activity should be directed by a civilian agency exercising the control over aeronautical and space research sponsored by the United States, except and insofar as such activities are closely related to missions of the Department of Defense, in which case the agency is authorized to act in cooperation with, or as an agent of, the Department of Defense."

The rewording of the act suggested is submitted as a drafting service only and does not necessarily represent a policy position of the Department of Defense or the Department of the Army.

Your interest in this matter is appreciated and I hope the suggested amendment will be satisfactory for your purpose.

Sincerely,

J. H. MICHAELIS,
Major General, General Staff,
Chief of Legislative Liaison.

Mr. FULTON. Going a little further, look at line 10. It says "On behalf of the Department of Defense." Do you want the National

Space Agency operating on behalf of the Department of Defense?

General DALEY. Yes, sir, under certain circumstances, I can certainly foresee this. If this National Space Agency were engaged in a program which was primarily a civilian program, we will say, but one in which there was information which we could derive from that program, which would have military value, and a program which it would be more expensive or less efficient for us to handle within the military, I would like the right to go to this Agency and say "Will you, on behalf of the Department of Defense, do this for me?"

Mr. FULTON. Should it be specified more clearly as to the method of procedure that we should legislatively set out to accomplish that result? For example, should it say "By agreement of the space agency and the Secretary of Defense" or "by the approval and the instructions of the President?"

How should we accomplish that? If you and the good doctor will submit us language on that at this point, it would be helpful.

General DALEY. I might say at this point I will reexamine the words very closely. I had accepted this language as perfectly satisfactory. I will discuss it with Dr. York later.

The CHAIRMAN. Suppose there is a conflict on the language referred to by Congressman Fulton as to what activities may be peculiar to, or primarily associated with, weapons systems or military operations. Who would make the decision? Suppose this agency says it is not and the Defense Department says it is. I suppose you would go to the President, then, would you?

General DALEY. Yes, sir, I assume so. Actually, this does have a way of getting settled, too, some times, when you have to go up and stand up and state your case. If you have some weak points in it, you backwater.

The CHAIRMAN. And, particularly, when research and development commenced to be appreciated by the Defense Department. It wasn't so many years ago was it?

General DALEY. Yes, sir.

Mr. FULTON. Are you through, sir?

The CHAIRMAN. Yes.

Mr. FULTON. May we have your comments on the necessity and the urgency of the development of the million-pound thrust engine? Do you think it is, first, necessary, and, secondly, should we go on to an accelerated program of some size in its development?

General DALEY. In my personal opinion, yes, it is necessary.

Your capabilities in the satellite field today are definitely limited to the size of the engines that you have available. If you fail to provide for larger engines in the future, then you have reached the limit of your capability. A million-pound thrust engine appears to be technically feasible. I think it should be undertaken. I believe not on a crash program, perhaps, but with a reasonable effort, this is really something that is in the province of the Advanced Research Projects Agency, they must weigh this against their other requirements.

Mr. FULTON. Would you give us the time in which you think it could reasonably be accomplished on an accelerated program, and, likewise, an estimate of the overall cost? What agency should be primarily entrusted with the program?

General DALEY. I was asking Dr. York if there was anything classified in this. I would say that I think you would get such an engine,

a good engine, in 4 or 5 years. My own estimate of the cost of this, and this is a complete cost of fuels, burning up engines and everything else—this is a big engine that will burn tons and tons of fuels while developing—it will cost in the order of $200 million over that period.

Mr. FULTON. What agency would you entrust the operation to? The Army Ballistics Division?

General DALEY. I am a very biased and parochial witness, sir. I would simply say that I think the Director of the Advanced Research Projects Agency or his scientific advisers should tell you.

Mr. FULTON. Who should do it, Dr. York?

Dr. YORK. Well, I think it should be done by one of the big companies which is presently in the big rocket field.

Mr. FULTON. What Government agency should have such supervision is really what I am saying, of the planning, research and development?

Dr. YORK. I feel somewhat parochial, too. I think I would have the Advanced Research Projects Agency do it, my self.

Mr. FULTON. Could I ask this question? Would you at the same time carry on a third of a million pound thrust engine development, or would you also carry on a million and a half pound thrust engine development, starting just about the same time and realizing they have different termination points?

Or is that too broad a program?

General DALEY. These things must always be weighed against finances. I would say I would start to work on a third-of-a-million-pound thrust engine at the same time. There has been work done in this field in the past. It is an easier job than the bigger one, obviously.

Mr. FULTON. In what magnitude, generally, of cost would that third-of-a-million-pound thrust engine run? Also give us the timing.

General DALEY. May I furnish that for the record?

Mr. FULTON. Certainly.

(The document referred to follows:)

DEPARTMENT OF THE ARMY,
OFFICE OF THE SECRETARY OF THE ARMY,
Washington 25, D. C., May 20, 1958.

Hon JOHN W. MCCORMACK,
Chairman, Select Committee on Astronautics and Space Exploration, House of Representatives, Washington, D. C.

DEAR MR. MCCORMACK: The following information, requested of Maj. Gen. John P. Daley, during his appearance before the Select Committee on Astronautics and Space Exploration on April 24, 1958, is furnished for the record.

It is estimated that the development of a one-third-million-pound thrust rocket engine using chemical fuel would require 4 to 4½ years if carried out by an agency experienced in the field of large rocket engine development. The cost of such a development is estimated to be approximately $75 million.

The estimated total number of Government personnel engaged by the Army in ballistic missile and space matters 3½ years ago was approximately 2,500; the total contractor personnel similarly engaged at that time was 12,800.

The estimated total number of Government personnel currently engaged by the Army in ballistic missile and space matters is 6,600; the total number of contractor personnel similarly engaged is 69,000.

Sincerely yours,

J. H. MICHAELIS,
Major General, General Staff,
Chief of Legislative Liaison.

Mr. FULTON. Do you think there is any gain to be made, as suggested yesterday, by going into the production of a million-and-a-

half-pound thrust engine rather than a million pound? This would be on the basis that you get very little more expense and little more time to get the bigger one, and then you have passed the million-pound-thrust engine on the way to the million-and-a-half-pound-thrust engine?

General DALEY. I am really not a technical expert in these matters. However, our advice is that about a million is what should be tried. If you wanted a million and a half, you would probably cluster, possibly, some smaller engines.

Mr. FULTON. Would you advise current study of research and development on the ion engine, the ion propulsion for space vehicles?

General DALEY. There should be some study in this field, sir, but I consider this as much farther in the distance than anything we have been talking to, to this point.

Mr. FULTON. But you would continue that study and not stop any study that is now in progress?

General DALEY. Yes, sir.

Mr. FULTON. Do you consider light propulsion practical enough at the present time to have a basic research program in operation on it?

General DALEY. Basic research, really basic. But this is further out in the future, in my opinion.

Mr. FULTON. Do you feel that there should be a basic research program on solar energy propulsion with the sail effect as distinguished from the light propulsion?

General DALEY. This I am not familiar with, sir. I will say this, that as a general philosophy, if a thing is based on sound, physical principles, and we know principles which might have application to propulsion and in which we do not have all the scientific knowledge that we need, this is the kind of thing that I would look to the laboratories to explore, to push back the limits of our knowledge so that we can tell whether or not these things do have practical application.

Mr. FULTON. Would you start, if you were having the power of decision, on an immediate program for a space vehicle on the order of the kind proposed by the director of the projects analysis of Convair, the astronautics division of Convair, of San Diego, who was here yesterday? Would you try to put men into space for military purposes or simply as a space vehicle at the present time, by starting a program immediately to do that?

He says it can be done quickly, within a reasonable number of months, and for about a half billion dollars. By a reasonable number of months, I mean a few years.

We are leaving the time indefinite. But would you start now to try to do such a program practically?

General DALEY. I can't tie my remarks specifically to the Convair proposal, because I am not familiar with the Convair proposal. I believe that we should take the first steps in putting a man out into space, and this is not necessarily into an orbit.

Mr. FULTON. Then you believe with Von Braun that it would be of practical research and development value to put a man in a capsule that would go 150 miles in the air to see what would happen?

General DALEY. It is more than to see what would happen, sir. I have discussed this with some doctors of medicine, space people, and I think this would get us information on the problems of man living

in space. This, however, of course, must be weighed against the rest of the projects that the Advanced Research Projects Agency has. I think it is a practical proposal.

Mr. FULTON. It is a necessary, practical step to you, though in the development of further space flight, and should be tried, rather than classing it in the position of shooting a woman out of a gun.

General DALEY. I completely disagreed with that remark, sir, which I read in the papers.

Mr. FULTON. Well, the papers were not quite accurate, I believe, with regard to Dr. Dryden's position, but there was no distinction made as to what it might be.

It was a comment that he would not like to see projects developed such as shooting a woman out of a gun, but I don't believe he exactly equated Dr. von Braun's proposal to that. I say that in defense of Dr. Dryden.

General DALEY. I disagree with many people that I respect a great deal.

Mr. FULTON. Let me finish on this, and I will be through. Am I going too far?

The CHAIRMAN. The chairman has not limited any member yet.

Mr. FULTON. Thank you, Mr. Chairman.

In conclusion might I say this? Would you give your estimate of this lunar shot as to time? How soon can we, in the United States, make one when we have the Jupiter-C, the Thor, the Atlas, the Vanguard as boosters? Why don't we just take a straight shot at the moon without a lot of instrumentation and see how close we can come?

General DALEY. You must actually modify hardware to do this. Even something that you can say is practical with devices that you have, still takes time to put together. This is why you just can't, or I can't, or Dr. von Braun can't, walk down to Cape Canaveral, put up a Jupiter-C, and shoot up at the moon. A lot of people have to do a lot of things to that vehicle. Even if it has the proper propulsion, the guidance and everything else, these things have to be worked on, and it takes months to do it.

Mr. FULTON. You and the good doctor sitting next to you have the responsibility for doing it, don't you?

General DALEY. We have the responsibility for making such a shot; yes, sir.

Mr. FULTON. What kind of a program are you putting on to do it?

Is it simply an accelerated program, a crash program? Are you doing it in deference to the fact that there may be a race with Russia to see who gets to the moon first? Is that in your thinking? Or are you just going about it on a scientific development pattern that has other factors that you don't want to interrupt, other programs now existing?

Have you given it the clear green light, like developing synthetic rubber during World War II?

Is this a program which is taken up in relation to other research and development programs you might be working on?

General DALEY. We stated our best capabilities to do this and certain other things to the Advanced Research Projects Agency. Certain of these projects were funded, based on our capabilities. I do not believe that we could materially shorten the time scale of the various things that we are doing.

Mr. Fulton. It has a first priority with you, though, so that no other project is holding it back?

General Daley. There has been no conflict that has held it back. We would face quite a decision, for example, if there were a direct conflict with the Jupiter, which is a national program. We would have to go above the Department of the Army level before we resolved such a conflict. To date we have been able to avoid it.

Mr. Fulton. How long do you think it will be before you can put a man in some kind of an instrument that would shoot him to Europe? How long will it take? That is, in view of the shot today of about 5,500 miles that took—what? 30 minutes, was it?

General Daley. I imagine that shot took on the order of 30 minutes.

This is what it would take a man to travel there. There are a lot of other things in between, of course. The man who went would like to be in good shape when he arrived. This is quite a problem. This is quite speculative on my part. I would bow to Dr. York or almost anybody on how long this would take.

Mr. Fulton. What is your judgment at this time?

General Daley. If you set out to do it, in this specific thing, perhaps 5 years or maybe 10 years.

Mr. Fulton. Thank you. That is all.

The Chairman. Mr. McDonough.

Mr. McDonough. General Dailey, I appreciate your appearance here and the information you have given the committee. In the fourth paragraph of your statement, you outlined certain things that you thought were essential, for satellite exploration, reconnaissance, surveillance, meteorology, and navigation.

You don't say anything about weather. Everyone else coming before us has stated that weather is one of the most important items.

General Daley. I included weather, sir, under the broad terminology of meteorology, of studying the whole effects within the atmosphere, the wind currents and everything else. I included weather under the heading of meteorology.

Mr. McDonough. We had a witness yesterday or the day before yesterday, Dr. Ramo, who estimated that weather was the most vital thing, especially to the military, for the use of a satellite orbiting the earth. Do you agree with that?

General Daley. No, sir, I do not. I believe that weather is a very important contribution. I think possibly from the civilian standpoint weather might be as important to the civilian, or more important to the civilian, than to the military. I think this is one that is mutually supporting.

But from a military standpoint, I think possibly reconnaissance and surveillance would rank higher in my own mind.

Mr. Fulton. A California Congressman should not be too worried about the weather, should he, General?

Mr. McDonough. Not in California. I am talking about around the world.

Do you think that the average citizen realizes the importance of space exploration?

General Daley. Sir, I would say that this committee is a great deal better judge of the average citizen than I am, but it is my opinion that the launching of the satellites, the very fact that these committee hear-

ings have been going on, and have been on the front page of most of the newspapers that I have seen, you are educating the people so that they realize the importance of it.

Mr. McDONOUGH. I think it is fascinating, and has challenged the imagination of the average citizen. But whether they realize the significance of it from a military and economic point of view is the thing. I wondered if you had any opinion on it especially. You have been in it for some time.

General DALEY. I have a feeling that the average citizen is becoming more and more aware of it. I would say that certainly it is a long educational process.

Mr. McDONOUGH. Insofar as you are concerned, do you think we are at the present time progressing fast enough in the development of missiles, satellites, and rocket development?

General DALEY. Sir, I think if I were completely satisfied, they ought to throw me out. No, I am not satisfied. I think that I always ask for more money than I get, and this is a natural consequence of democratic government. I understand this.

But, obviously, I woud like to push things faster if I knew how. I am not always satisfied with my own performance or the officers that work with me, though generally I am.

It is just a case of push, push, push.

Mr. McDONOUGH. Are there practical things that we could be doing now, if we had more money to do them with, that would augment, supplement, and expand our military potential in missiles and rockets?

General DALEY. In big missiles, I think that the amount of money that has been made available by Congress, the amount of effort that is represented by industry and by Government agencies, representatives, in the big missile field, and I include our Jupiter, constitutes practically a maximum effort at this time, or at least a maximum useful effort.

I question whether more could be spent wisely.

Mr. McDONOUGH. That is the point I wanted to make.

General DALEY. In the satellite field it is a question of judgment on how much you could spend. You could spend more. Whether this is wise or not, I don't know. This is up to the director of the Advanced Research Projects Agency.

Mr. McDONOUGH. Does your office have anything to do with the present construction of a spaceship, manned or unmanned spaceship, or am I asking for classified information?

General DALEY. Sir, that is what I was trying to decide. We are authorized, certainly, to investigate this. This is as much as I care to say on the subject.

Mr. McDONOUGH. The Pied Piper is not under your jurisdiction, is it?

General DALEY. No, sir; it is not.

Mr. McDONOUGH. That is a known spaceship being constructed?

General DALEY. It is a spaceship, but I don't believe a manned one.

Mr. McDONOUGH. I notice you said something about the Atomic Energy Commission operating in one field and the Space Agency in another.

Don't you think there is a correlation of the two that will require a direct connection, because certainly we are to use nuclear power

for propulsion and there should be a closer relationship than what you indicate.

General DALEY. I feel sure that we must explore, develop, find out how to use nuclear propulsion in these vehicles.

I am sure this, compared to a chemical rocket, is a longer range program. I am sure that the Atomic Energy Commission and its laboratories must contribute to this.

I do not believe that this necessarily means that the two organizations have to be one.

Mr. MCDONOUGH. I agree with that, not one, but there should be a very close working relationship.

General DALEY. There must be close working relationships, yes, sir.

Mr. MCDONOUGH. In that connection, the bill provides for at least one representative from the Defense Department. Do you think there ought to be more than one from the Defense Department and one especially for nuclear power, for propulsion and for ballistic purposes?

General DALEY. If there were more than one from the Department of Defense, it would be my opinion that it would be probably preferable to appoint them on the service basis as is now done in NACA where you have an Air Force, Navy, and Army representative.

As far as the representation in the atomic energy field, the bill certainly permits it. I would suppose that if it were necessary that the representative here would probably come from the Atomic Energy Commission or its laboratories.

Mr. MCDONOUGH. That is all, Mr. Chairman. Thank you very much.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. General, you consider, do you not, that it is not fanciful, but it is practical, for us to talk about future transportation of man and material in a capsule form by shooting him up in the air in a rocket and landing him some distance away?

General DALEY. It is fanciful to the extent of talking about it in the immediate future. I can well foresee that as you learn more about moving through space that this is a possible way of transporting men and material, a way which should be investigated.

If it were done in terms of today's hardware, the economics today would ruin you. On the same basis, I think if anyone talked about transporting men to Korea by aircraft from California or from Washington back in 1915 or something, the cost also would have been staggering, but it came about.

I simply think this is out in the future, not something for tomorrow.

Mr. KEATING. But you have drawn a very reasonable analogy in my thinking between the two. We are in the early developmental stage in this entire area and we have to look to the future in our thinking.

General, you discussed with one of the members a department of science and we are inclined to think that was undesirable at the moment. Let us put that aside for the moment.

Do you consider that the director of this agency should have a voice in the formulation of national policy at the very highest level, similar, let us say, to the Chairman of the Atomic Energy Commission who sits, at times, with the Cabinet and with the National Security Council?

General DALEY. Within his field, the director should have access to the President, in my opinion. This, however, I do not believe necessarily means sitting in on all National Security Council meetings or things of that nature.

However, I think he should have access to the President and he should be certainly completely informed on everything that goes on at the top levels of the Government so that he can tell when his things are affected and when he can affect things that are going on.

Mr. KEATING. Of course, he should have a voice in anything that affects space.

General DALEY. That is correct, yes, sir.

Mr. KEATING. There is no reason why we could not have a liaison arrangement with the military or any other department of the government without putting it in legislation?

General DALEY. That is a correct statement; yes, sir.

Mr. KEATING. Do I understand it to be your feeling that that is a better way to handle it rather than lay down the lines of liaison in legislation?

General DALEY. That was my statement. In my opinion, I would not put it in legislation at this time.

Mr. KEATING. It leaves it a more flexible arrangement, if you can handle it through administrative channels?

General DALEY. I am not sure whether it is a more flexible arrangement but it does not prejudge what the setup will be.

Mr. KEATING. Do you look upon astronautics and aeronautics as two entirely different fields?

General DALEY. Not entirely different, but considerably different, sir.

Mr. KEATING. Do you look upon outer space as different from the atmosphere immediately above the earth in kind or degree?

General DALEY. I recognize that this is a limit, that you cannot just draw line through it, but the kinds of vehicles that will move in what you call outer space are not the kinds of vehicles that move from Washington National Airport now out to the other cities in our land.

These are air-supported vehicles. The characteristic of space as it exists today or what we call space is such that the air is rare enough so that it won't support the vehicles we know today.

Mr. KEATING. General Schriever testified this morning that about 3½ years ago, and these were rough figures, there were about 5,000 people engaged in all employment related to what he calls space matters.

Today there are 80,000 roughly and he forecast an increase in that figure.

Could you give us any comparable figures for Army development? The Army, I guess, perhaps has done more of this development—what is the phrase you use, in-house?

General DALEY. In-house is the phrase that has been used.

Mr. KEATING. More than the Air Force, is that right?

General DALEY. Yes, sir. There is no question about this because we have used our Army Ballistic Missile Agency, the team headed by Dr. von Braun who spoke to this Committee, we have used that team as a nucleus around which much of our work has been done.

Mr. KEATING. It is only rather recently that the Army has contracted for the development?

General DALEY. We do a considerable amount of the work by contract. It is not actually performed, much of it, at Huntsville, Ala., by the Army Ballistic Missile Agency, but we have used as the guiding engineering talent, the talent of the Von Braun team and they have done some of the work at the Army Ballistic Missile Agency, a large part of it has been let out to contractors like Chrysler, Ford Instrument Co. We do a lot of our satellite work at the laboratory of the California Institute of Technology.

There is a difference, though, because the Air Force generally even puts the systems development out and therefore puts more in this field than we do.

Mr. KEATING. Would you be able to give us any comparable Army figures?

General DALEY. I can furnish them for the record, sir.

Mr. KEATING. Suppose you do that.

General DALEY Yes, sir.

Mr. KEATING. Thank you very much.

(The information requested is on file with the committee.)

Mr. O'BRIEN (presiding). Mr. Ford.

Mr. FORD. I have no questions. I have been fortunate enough to have heard General Daley a number of times on our other committee, and I think, for the purposes of this committee, most of the questions have been asked.

Thank you very much, Mr. Chairman.

Mr. O'BRIEN. If I may say, I did not ask any questions at the beginning and I have only one brief one now which may or may not be pertinent.

We have had considerable testimony here as to whether we are utilizing now as much of the scientific capability as we have in this country.

The thought occurs to me, is the military utilizing as efficiently as it should the talents of the young engineers or scientists who may come to the military through the draft or enlistment?

General DALEY. Sir, I would say in the first place that as efficiently as we should would be 100 percent efficient, and I am sure we don't do it, but I am sure that we are trying and we do have procedures that provide for highly qualified scientifically trained individuals to be put into jobs where we can make use of their scientific talent.

You will find considerable numbers of these individuals working at the Army Ballistic Missile Agency. You will find them working at White Sands Proving Ground. You will find them working at Fort Bliss in the missiles schools there.

These I know from personal experience. I have met them, I have seen them, and I have heard them make briefings. We are aware of the fact that there is still talent and we want to use it.

The only way to use it would be to use it perfectly and I am sure we don't.

Mr. O'BRIEN. I did not intend that even indirectly as a criticism. I wanted to bring out a point that where we do occasionally have a snafu like a highly trained young man peeling potatoes, that is the exception to the rule.

General DALEY. It is, sir.

Mr. FELDMAN. General, I would ask you again to address yourself to the language in the bill which reads:

Except insofar as such activities may be peculiarly associated with weapon systems or military operation.

The United States Weather Bureau, the Army Signal Corps, the Air Weather Service, the Naval Bureau of Aeronautics are all interested in weather.

Where would you put meteorological satellites?

General DALEY. I believe that I would probably put it under this National Space Agency and I would probably execute the work through the Advanced Research Projects Agency and through the existing military departments.

Mr. FELDMAN. Somebody might disagree with you on that conclusion, is that not so?

General DALEY. I am sure they might. I thought that was a very wise question you asked.

Mr. FELDMAN. How would you resolve it except through some liaison?

General DALEY. The primary way to resolve something like this would be, if this Agency were set up, the director of this Agency and Mr. Johnson of the Advanced Research Projects Agency, would have to sit down together and state their case.

Initially I think what would happen is that somebody at a lower level in each agency would sit down and the reason I gave the answer I did was that I thought it does have wide civilian application, but the resource to do this quickly lies within the Defense Department.

Mr. FELDMAN. You will agree that there might be a number of other instances of this kind?

General DALEY. That is right.

Mr. FELDMAN. And the director, who is on top of an agency of that kind, should be relieved of as many of those functions as he can be. At least, he should be so briefed on them that he does not have to spend so much time with them that he is unable to do his job in an orderly and efficient way. Is that not so?

General DALEY. That is correct.

Mr. FELDMAN. Now, the proposed Space Agency creates an Aeronautics and Space Board that is to meet no less than four times a year.

The Chairman of that Board is not to be from any branch of the government and is to be appointed by the President.

We are told that the reason he is not to be a Government representative or a military representative is because there might be a conflict of interest involved.

Are you acquainted with the membership of the NACA Board as it is presently constituted?

General DALEY. No, sir, not personally.

Mr. FELDMAN. There are some members on the Board who are employed by companies or connected with companies that are engaged in the making of hardware.

The new proposal gives the new Agency the authority to build hardware. Might there not be the same conflict of interest which Dr. Dryden told us about the other day, when he testified in that situation

as there would be in the case of a Government representative serving as a chairman?

General DALEY. I am not a witness as to the conflict of interest or whether there is one in the NACA. I accept your statement.

Certainly there is a chance for a conflict of interest. There is, to me, a somewhat different connotation here, though, and that is that the object here is to make a civilian space agency and it seems to me that one of the first things I would want in a civilian space agency is a civilian director.

Mr. FELDMAN. We are not talking about the director now. We are addressing ourselves particularly to the Space Board.

General DALEY. This says that the Chairman of the Space Board shall not be military.

Mr. FELDMAN. That is right.

General DALEY. I find nothing to argue with this. Frankly, I think this is a civilian agency. The military representation is possible, but making the chairman a civilian seems perfectly appropriate to me.

Mr. FELDMAN. I was not addressing myself to the fact that he should not be a civilian. I was addressing myself to the fact that Dr. Dryden stated that the reason why he should not be a military man and the reason why he should not be otherwise connected with the Government is because there would be this conflict of interest.

In other words, if he happened to be from the Air Force he might favor the Air Force. By the same token, using that as a premise, would not a civilian who was appointed Chairman of the Commission, who was connected with a company or had an interest in a company or had stock in a company that was making hardware that might be used by this Agency, also be subjected to the same criticism, namely, the conflict-of-interest charge?

General DALEY. Sir, obviously he could be charged with a conflict of interest. I arrived at my reason for having a civilian chairman not for the same reason that Dr. Dryden did. I think for a civilian agency it is good to have a civilian in charge.

Mr. KEATING. I think perhaps the counsel has not gotten through to you as to the provisions of this bill which have nothing to do with military or civilian. The bill says that not more than 8 of the 17 shall be connected with any department of the Government, and then, presumably, there would be 8 from the Government and 9 from outside. Dr. Dryden's point of view was that the bill says that the Chairman shall be chosen from outside of the Government. Dr. Dryden made the point that the Chairman might just as well be from within the Government, because there would be the same conflict of interest outside the Government as in.

The reason given for selecting the Chairman from the nine outside of the Government was that, if they were in the Government, they would have a conflict of interest, not necessarily military. But, if they chose one from the military, he might favor the military, or the Atomic Energy Commission, or the Weather Bureau. They might have a slant in that way.

I guess what counsel wanted from you was whether you felt that the same conflict of interest might apply outside the Government as well as inside.

Mr. FELDMAN. I was thinking of the present constitution of the NACA Board and the possibility that, since it is the block upon which the new Agency is to be built, it might be lifted over, in toto, and there might be some criticism along the lines I discussed.

For that reason, I am trying to prevent that embarrassment from occurring.

Mr. KEATING. I do not suppose there would be any embarrassment in moving the Board over from the NACA. If that was anybody's thinking, it certainly was not mine.

Mr. FELDMAN. That is partly what I had in mind. General, I want to ask one more question. This proposed Space Board would have no power except to recommend. In other words, the Director does not have to accept any recommendations; he can do as he pleases. So, the function of the Board is purely advisory. Now, I also thought that the word "advisory" meant just what it said, give advice, and that you could not use that as a liaison agency.

The word "liaison," to me, means coordination. It means letting the right hand know what the left hand is doing. If you are of the view that, because you had representation on this Space Board, therefore, you had liaison with the new Agency, I would ask you to reconsider your answer. Please do so in the light of the fact that No. 1, the Space Board would meet no less than 4 times a year, probably 8 or 10 times a year, and, secondly, the fact that I believe liaison requires being in constant touch with what is going on in the agencies involved.

General DALEY. I certainly agree with your last remarks. I would not say that this meets the requirements of liaison. It helps; it would mean that you would be there and have a representative present any time they initiated a major policy or made a major program change, because they will be consulted prior to this time, the Board will. However, you must have a day-to-day contact.

All I am saying is that I do not believe it is necessary to spell out out in this law, nor do I think it is desirable to spell out in this law, how that liaison will be created at this time.

Mr. FELDMAN. What harm will there be in doing it at this time?

General DALEY. I certainly believe in laws, but I believe when you lay down too many administrative details in laws they come back to haunt you. This is the only thing that worries me.

Mr. FELDMAN. If you have a body with the experience of the AEC, which has proven that you do not have anything to haunt you, you want to borrow from that body of experience, don't you?

General DALEY. That is correct, and I am a member of the Military Liaison Committee. My personal opinion is that I would not put that into this law at this time. It is quite a possibility you might want to, a year or two from now. But I would say set up the agencies and find out.

Mr. FELDMAN. If you have found out, on the basis of experience, that it is a good thing, wouldn't you want it in the law itself? It is not a basic provision.

Mr. KEATING. You would see no objection to having a sentence that there shall be liaison?

General DALEY. No, sir.

Mr. KEATING. All you object to is setting up the details as to how the liaison is to be accomplished; is that right?

General DALEY. That is right.

Mr. FELDMAN. I will say that you are the only military man who has objected to it.

General DALEY. It is not the first time I have been alone, sir.

Mr. KEATING. That is not my understanding of the testimony. I think, if you refer to the question put to the other members of the military, I think the question that was put to them was, "Would you favor setting up liaison between the military and the civilian?" Probably, they meant just what the general says, that to have a sentence in there saying there shall be liaison is fine. But I did not understand that the others had said that we should outline the details of just how that was to be effectuated. If that was so, it escaped me.

The CHAIRMAN. I asked questions of them, and my recollection is pretty much the same as Mr. Feldman's, except that I agree we did not discuss writing out the details. That was not gone into. You would not have to write out the details. That depends on the sense of responsibility that exists between understanding men. You can write all the details and, if the men are stubborn, you will not get anywhere. They, first, have to have an understanding and appreciation of their trust and the overall national interest. I assume that will exist.

Once in a while you meet a situation where it does not. So, I do not think there is much difference all around. As a matter of fact, it was thought by some of us that the liaison group, based on the experience of the AEC, would have a strengthening influence, particularly in this trying period, from the angle of the military, which would inure to the benefit of our country. It would enable them constantly to get information, to keep in contact, and to have their views represented over and above this 17-man board, whatever the representation might be on that.

Mr. KEATING. I am not familiar with whether the AEC law sets up the method by which liaison shall be effected or whether it just deals with the subject in broad terms.

Mr. FELDMAN. Relatively broad terms.

General DALEY. The Military Liaison Committee was established by the law establishing the Atomic Energy Commission.

Mr. KEATING. Your impression is that we are not ready for that step yet with regard to a space agency?

General DALEY. That is correct.

The CHAIRMAN. Why not?

General DALEY. Sir, this really has very little to do with the establishment of this particular Board. It is my feeling that you are setting up a new agency. It is dealing with another relatively new agency representing the Department of Defense. Set these agencies up. Let them establish liaison. They will establish liaison. They have to establish liaison.

Mr. FELDMAN. On a hit-or-miss basis?

General DALEY. On this basis.

Mr. FELDMAN. On a hit-or-miss basis, it could be, if it was not in the law.

General DALEY. It could be, if you get an inefficient director and an inefficient director in the DOD.

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Mr. FELDMAN. Precisely. When you draft something, an order or anything else, whether legislation or whatever the document is, you want to make that as specific as you can so that there can be no misunderstanding, if you can avoid that misunderstanding at the outset.

The CHAIRMAN. You are giving one man a lot of power, are you not?

General DALEY. Yes, sir.

The CHAIRMAN. Particularly in the Director, like in Defense, because over him there is the Secretary of Defense. In a democracy, you realize the fact that this man is going to have a tremendous amount of power?

General DALEY. That is correct, sir. Any time that you give a man great responsibility you must give him equal power. I believe that he, within our democracy, is controlled by the fact that he is subordinate to the President. He is controlled by the fact that he must come to the Congress and explain what his programs are.

He must defend his money to the Congress, he must serve the executive branch of the Government, he must serve the legislative branch of the Government, and furthermore, when you establish the laws, he must serve the judiciary.

So I believe you are protected.

The CHAIRMAN. That is very nice and very correct, but there are an awful lot of things that go in there. Those of us who have been in Congress more than 30 days know just what the human difficulty is.

General DALEY. I think the most expert witnesses are sitting around here, sir, and I should probably be asking the questions.

The CHAIRMAN. I would not agree to that, but I would not deny it.

Mr. FELDMAN. I have just one more question.

Are you aware of how long it takes for an amendment or statute to go through the Congress?

General DALEY. No, sir, I am not.

Mr. FELDMAN. Well it takes a long time.

Mr. KEATING. It depends on the circumstances.

Mr. FELDMAN. I am talking about the average. You just cannot press a button and get an amendment through.

General DALEY I am sure that is true.

Mr. FELDMAN. Consequently, if you can get a good job done from the outset, from the drafting experience, from the administrative point of view, from a political science point of view, it is a good thing. You do that in your everyday work in the military, I am sure.

Mr. KEATING. I will just make the comment to counsel that the chairman of this committee has sufficient influence to get an amendment through the House of Representatives. I saw him the other day introduce a bill and 5 minutes later it was passed.

The CHAIRMAN. That is true, but before that was done, the majority leader consulted with the minority leader, the minority leader consulted with the ranking members on his side of the committee, and the majority leader consulted with the ranking members on the majority side and we cleared it through the Speaker.

Mr. KEATING. That is the way the gentleman operates.

The CHAIRMAN. I agree that there must have been some pushing force. That is all right. There has to be a motivating force.

I like to have the benefit of other views. I find that I am wrong, myself, so often. You gentlemen here have helped me inestimably on

this committee, and I have kept you working morning and afternoon with all my other work.

Other than the driving force, I probably have not contributed much. But it is a matter of consultation. I do not think there is much difference between any of us and the general.

I think in this period of the world's history, I would like have John McCormack, an American who is on the civilian side of Government, know that the viewpoint of the military will always and completely be expressed.

That is the thing I have in mind. You do not quite grasp my viewpoint, I think.

General DALEY. I think I understand your point of view, sir. Maybe I am more optimistic as to whether this would work or not, as to whether I would get an opportunity to express my viewpoint.

Mr. METCALF. I am glad that you have expressed a viewpoint, General, that is somewhat different from the other members of the military, especially as a member of the military liaison committee and the experience that that committee has working with the Atomic Energy Commission.

I respect your opinion because of your experience. You are suggesting that we make a general declaration of policy, perhaps in section 1, that there should be constant and continuous liaison, and then leave it up to the Director to set up the kind of liaison that he feels will be most efficient and then wait a while until we see how that works before we write that into legislation.

Is that your suggestion?

General DALEY. That is correct, sir. If it needs a modification, I would make it a general modification. I would not spell out as the law presently does. The Atomic Energy Act says there will be a chairman and it tells who he will be and it says there will be at least 1 representative, at least 1, although there can be 1 from the Army, Navy, and Air Force, and it spells out the duties in detail.

I think it is premature to put it in this bill. Now I can be wrong.

Mr. METCALF. I think as a member of the committee that is functioning and a very experienced individual in this whole field, your opinions are entitled to a good deal of respect. So perhaps we should say here in the enumeration of activities on page 2 of the part of the declaration on policy that there shall be constant, continuous liaison with the military over and above the liaison that will necessarily be established as a result of the creation of a member on the Board.

General DALEY. This to me might even strengthen the bill.

Mr. METCALF. Thank you, General.

Mr. O'BRIEN. General, I know there will be one more question. We have on the committee a Navy lieutenant who is trying to get promoted. He has had some difficulty in a recent examination.

He has stated his problem to all of the learned witnesses who have appeared here. Perhaps I do not state it accurately, but it spells out something like this to me.

If a man is going in six different directions at the same time, at the same speed, where is he going?

Do you have an answer to that?

General DALEY. No, sir. I am afraid I do not.

Mr. FULTON. Could I restate it?

Mr. O'BRIEN. Go ahead.

Mr. FULTON. We received this question on the Navy reserve promotion point list: "If a vehicle or missile is in a position where the thrust equals the drag and the lift equals gravity, what is that vehicle or missile doing?"

I wish you would not consult with Dr. York.

General DALEY. I would have flunked the Navy examination.

Mr. FULTON. Maybe the three of you could answer that.

Dr. YORK. It is flying steady, that is all.

Mr. FULTON. That is to say, constant, level flight?

Dr. YORK. Yes; that is what I meant, flying steady straight and true.

Mr. FULTON. Is it in a line conforming to the circumference of the earth or is it a plane that, as it comes out of a climb, reaches the stall point.

Dr. YORK. It is flying straight and steady, flat.

Mr. FULTON. A straight line or parallel with the earth's circumference?

Dr. YORK. It could be either. I don't think when the question was asked they had that kind of detail in mind.

Mr. FULTON. Would you have to say something about a constant velocity?

Dr. YORK. That is what I meant by steady; yes.

Mr. FULTON. It is not a plane that reaches the peak of its climb and goes into a stall?

Dr. YORK. No.

Mr. McDONOUGH. It is not the same as an irresistible force meeting an immovable object?

Mr. O'BRIEN. General, I know I speak for the chairman of the committee and all the members in expressing our very great gratitude to you for your testimony and your frank response to the questions, even though I think you failed on the last one.

General DALEY. Thank you, sir. I am glad to have been with you.

Mr. O'BRIEN. Now we have Dr. Herbert F. York, Chief Scientist, Advanced Research Projects Agency of the Department of Defense.

Dr. York, welcome back.

STATEMENT OF DR. HERBERT F. YORK, CHIEF SCIENTIST, ADVANCED RESEARCH PROJECTS AGENCY, DEPARTMENT OF DEFENSE

Dr. YORK. At the behest of one of your colleagues, I am supposed to be catching an airplane at 6 o'clock. I have a statement about the role of ARPA in its relationships with NASA in all of this, presuming that there is an NASA.

I could either read it or leave it for insertion in the record, whatever you prefer.

Mr. O'BRIEN. Since you have that time problem, I would suggest that you put it in the record.

Mr. SISK. Do you have extra copies, Doctor?

Dr. YORK. Yes.

Mr. FULTON. Could you summarize it orally?

Mr. SISK. How lengthy is it?

Dr. YORK. Not very.

The CHAIRMAN. I think the doctor should use a little judgment. Give us a summary, doctor, and we will put your statement in the record.

Dr. YORK. The role of ARPA vis-a-vis NASA, presuming there is an NASA, as we see it now, is that ARPA will do the programs which are primarily military in nature, and would also do supporting development and research programs related to those.

Those programs which are primarily nonmilitary or primarily civil in nature, including such things as basic science, for example, would be done by the NASA.

There is a considerable gray area in between which we have to resolve. In some cases we would suggest that there be permitted a wide variety of methods of operating such as now exists between the NACA and the service.

We suggest that there be joint programs, that there be cooperative programs, and that there be coordinated programs.

In the case of a coordinated program, for instance, an example is satellite communications relay development where there are civilian applications. There are also military applications.

The military applications may very well be quite different. Security may be involved or something like that and there might very well be two communications relay programs and these would be simply coordinated so that the research and development results of one could be used by the other.

A joint program would be one where we actually set about doing a program something like, for example, the way the X–15 is being developed between the NACA and the Air Force and the Navy, the three agencies work directly together at most all points in the program.

Another way, at least for the time being, of deciding on who should do what in these gray areas, we would suggest, would be on the basis of who is best able to carry it out at the particular time.

As far as coordination with NASA, we have what I think is a fairly good start already in working with NACA. For the space science programs; that is, those which are basic science and which presumably under almost any reasonable definition here would go to NASA, we already have a coordinating board in operation.

This Coordinating Board consists of ARPA, the NACA, the National Academy of Sciences, and the National Science Foundation.

We work out what it is that should be done in the way of space programs, space science programs, and in fact what we do in general is that ARPA brings to this Coordinating Board the information on what vehicles can be expected, what capabilities are coming along, what are the possibilities for payloads, destinations of space vehicles, and so forth, transmits this information to the other members, and then in this particular the National Academy of Sciences, just as in the case of the present IGY year, there is a committee which goes over all of the proposals in the scientific community, establishes priorities, and so forth, and then it would be our hope that the National Science Foundation or some other agency with funds for basic research would support the payloads.

This sort of thing is already in progress and I hope would continue.

The way we are operating is that we do not assume that there will be an NASA when it comes to trying to round up support for funds, facilities, people, and so forth.

ARPA goes ahead as if there were not going to be an NACA or an NASA.

On the other hand, we take into account the fact that there no doubt will be something of this sort by always making sure that anything which could be even remotely considered as a civilian program is something which the NACA people approve of and we check over all of our programs with them as we go.

This is what we are doing in order to do what I think is extremely important and that is get a space program going right now and not wait for all of these questions to be resolved.

Mr. O'BRIEN. Does that complete your summary, Doctor?

Dr. YORK. Yes, sir.

Mr. O'BRIEN. Without objection, your full statement will be made a part of the record.

(The statement is as follows:)

Mr. Chairman and members of the committee, I appreciate the opportunity to discuss with you the role that the Advanced Research Projects Agency plans to carry out in the field of space technology. I shall emphasize the type of programs and projects that ARPA will carry out.

You are aware of course that the President has stated that ARPA will conduct for the Department of Defense those programs which are primarily of a military nature, and that other programs, those of a civil or commercial nature will become the responsibility of the National Aeronautics and Space Agency, if this organization is established as he has recommended to Congress. The emphasis here is on the words "primarily military" and is the guide that we must go by in selecting, in cooperation with NASA's predecessor the NACA, those projects that fall in our respective areas of responsibility.

I am sure that you realize that this selection is not an easy one to make for any specific project or program. It has been proven many times in the experience of the Department of Defense that developments that at first appear to have no conceivable military use will often have important implications on national security. These developments, then, may form the basis for new weapons that greatly reorient the strength of our military position with respect to other countries. Certainly some of the earlier explorations into nuclear physics fall into this category, and there are many more of lesser significance.

It is also true that many developments that appeared to be only of military interest have turned out to be of great benefit to the scientific civil and commercial interests.

We are generally prone to work on the subjects or projects that we know best how to do and that we can foresee will, with a high degree of reliability, provide a system that will solve a known problem. This is the easy thing to do and will lead to minor improvements in existing systems and eventually to complete obsolescence of our military weapons and technology. Accordingly, it is vital for us in maintaining our leadership in the technological area to look as far into the future as we can and grasp at every new idea to see if it has significance in the military sense

The primary purpose of the Advanced Research Projects Agency is to take this long look ahead for the Department of Defense on an integrated three-service basis and provide a source of new weapons technology from which the weapons systems requirements of the military services can be satisfied. The areas where it is most important to apply this service of ARPA at the moment are that of space technology and in certain aspects of the antiballistic missile field. With regard to space technology the Department of Defense, even when space was unpopular, and in fact was perhaps something to hide under the table, was active in studying its potentialities and had many small projects in being, ready to be expanded into military uses when the need arose. Advantage was taken and is being taken of the existence of large guided missiles as the basis for space vehicles for military purposes. Military rocket technology made possible the swift development of the Vanguard satellite launching vehicle, the launching facilities and the tracking network in support of the International Geophysical Year. This project demonstrates that the Department of Defense can work successfully and on the best of terms with the civil and

scientific community in a cooperative venture in which the Department of Defense is providing a nonmilitary service to the Nation. We have had a similarly successful relationship with the NACA in the past and expect to continue to do so in the future.

This brings us back to the problem of deciding what is primarily military in the field of space technology and what is scientific or civil or commercial. ARPA is currently in the process of working out with the National Academy of Sciences, the National Science Foundation, and the NACA a program for civil and scientific activities in the field of space, and with the NACA a method of operation whereby the two organizations can contribute their own best capabilities to the furtherance of the country's interests in the exploration of space.

Where it is apparent at a particular time that techniques or projects or systems are primarily military they will be retained by the Defense Department. Where it is apparent that they are not primarily military, they will be transferred, in due course, to the NASA. But there are many projects or programs where it is not possible to determine which side of the line these projects will fall. In this case we would propose that these be assigned on the basis of which organization is in the best position to pursue them. There will be other cases where rather similar endeavors will need to be carried out separately but on a coordinated basis between NASA and DOD and still others where the project will be carried out under the primary cognizance of one organization but with the very active participation of the other. It is most important, and I cannot emphasize this too strongly, that promising technological ideas must be developed by one or the other Agency rather than let such a possibility lapse by reason of uncertainty as to within whose responsibility it falls.

Mr. METCALF. As I understand it, Dr. York, your proposal would be that ARPA would continue to operate, if NASA is created, on the programs and the projects that are already underway?

Dr. YORK. Yes, sir. Well, I do not know if we are quite together or not. What I would do is to continue with ARPA as a permanent arrangement for handling the Department of Defense programs and requirements in space, that ARPA would coordinate and carry out within the Defense Department the programs which are, as the bill says, peculiar to or primarily military in nature, and I would certainly hope that the law were interpreted in such a way that that allows, in addition, research and development and was not narrowed in terms that all we could do was hardware systems.

In the meantime, we have a number of programs started. These can either continue under our direction or be transferred to NASA and I think the only criterion should be just simply whether they can be transferred in such a way that they do not lose any momentum.

I rather imagine that those things which are not too far off, such as the lunar problems and the other space science vehicles that we have already emphasized for ABMA and AFBMD, that we keep those.

Others which are further off, even though we start them, would presumably be transferred over at an appropriate time, as soon as the new Agency is capable of picking them up.

Mr. NATCHER. Do you favor a 17-man Board, Dr. York, or would you be in favor of a Board containing a smaller number?

Dr. YORK. I worked for the Atomic Energy Commission for many years up until a month ago and I am more familiar, so to speak, with the small and continuous Board that the Commission represents as opposed to the very large and occasionally meeting Board that is mentioned in the Board. That is where all my experience lies.

I like that way of doing things. I really have not seen enough of the other way to know that the Commission is necessarily better, but I am quite satisfied that it is a good way.

Mr. NATCHER. Dr. York, assuming that NASA is presently the law, we have the other agencies that we refer to from time to time, not only in our military services but otherwise that are doing considerable research work.

What suggestions do you have to make that should naturally follow after passage of this law insofar as they concern exchange of scientific knowledge, accomplishments, and achievements here in our own Government and in our own country, and insofar as they concern exchange between the different agencies, your Agency and the other agencies, the military services included?

Dr. YORK. Between us and other agencies doing similar work we would do it by what amounts to a continuous liaison, either formal or informal, just simply having our technical people get together with their technical people.

That will hapen on an informal basis. Where the coupling is very close, then probably one would set it up on a formal basis.

Mr. NATCHER. Do you feel, Doctor, that we have proper exchange of scientific knowledge today with our allies?

Dr. YORK. We could always have more. There is a growing problem. It has to do with the fact that information is being produced at an ever-accelerating rate.

I don't have any ideas on what to do about it. I know it is very easy to get behind in information even in a very narrow field because there is such a rapid generation of information.

Mr. NATCHER. Do we have too much classification so far as scientific matters are concerned?

Dr. YORK. I am certain with the enormous amount of classified information we have that some of it is probably overly classified and could be declassified.

I do not feel that there is a heavy preponderance of overclassified information. I am certain there is some. I run across it from time to time.

Mr. NATCHER. You are confronted with that from time to time in your present agency?

Dr. YORK. Well, yes. None of us, of course, has any important trouble getting information. On the other hand, there is information which would be of more general use.

When that comes along and we are aware of it, we try to do something about it. I am in the process right now of trying to get some things declassified in the next week or so.

Mr. NATCHER. Thank you, Mr. Chairman.

The CHAIRMAN. As a matter of fact, good leadership on the part of the Nation would be to let the world know, where it can probably be done, of discoveries and information, not only in this field but in all other fields?

Dr. YORK. Yes; certainly with any scientific information that comes from space and space satellites and so forth we should release it just as soon as we can.

I believe that is what we will do. I do not foresee any problem there. I think we will release what we get as soon as we get it.

Mr. SISK. Dr. York, how close has your association been with NACA?

Dr. YORK. In the last 3 or 4 months it has been fairly close with the top levels of NACA. I have never worked very closely with NACA as such.

I have known, personally, Dr. Dryden and General Doolittle for 4 or 5 years, usually because I was on some committee or other which they are also on.

Mr. SISK. My questions do not reflect any necessary criticism of NACA. However, as I suggested to Dr. Dryden the other day, it seems to me, of course, had they been the proper vehicle for this particular job, then there would not be any point of us worrying and trying to create another one.

Are they under direction now? I am referring to the Office of Naval Research under Adm. Rawson Bennett.

Dr. YORK. No, they are not.

Mr. SISK. Are you familiar with the work of the Office of Naval Research under Admiral Bennett?

Dr. YORK. Much of it.

Mr. SISK. How familiar are you with it over a period of years and the attainments of the Office of Naval Research?

I am speaking now back even to the Second World War.

Dr. YORK. I have seen bits and pieces of basic research that they have sponsored. I have been familiar with the Naval Research Laboratory for a half dozen years, I think, with some of the aspects of the Naval Research Laboratory.

Mr. SISK. Are you in any position to appraise, on a comparative basis, the attainments, let us say, of the Office of Naval Research as compared to NACA?

Dr. YORK. They are not very easy to compare because they are in quite different fields. The Office of Naval Research also does a great deal of research, has sponsored a great deal of university research by contract which NACA does not have anything to correspond. Very roughly they are comparable.

I do not know which I would say is better.

Mr. SISK. I realize there is no comparison in the amount of money. Of course, NACA gets some pretty substantial amounts of money.

The Office of Naval Research operates on a very nominal budget. I was interested, in view of some things I have heard and the few things I know, as to your comparison because I think the Office of Naval Research has actually made some substantial progress in the field which we are discusssing today as well as in other fields on, let us say, a far less amount of money than NACA has to play with.

Again, I am not being critical.

Dr. YORK. Are you including the Naval Research Laboratory in this or not?

Mr. SISK. To just what extent it works under Admiral Bennett at the present time as a part of the Office of Naval Research; yes.

Dr. YORK. Well, they have done good work. There is good work in both of these places, both NACA and ONR. It is difficult for me to compare them both on the basis I know, and perhaps I know them too well personally to make a good comparison.

Mr. SISK. I have no intention to put you on the spot, Doctor. Frankly, I might say that there have been things that would indicate that there has been a great deal of delay sometime in making decisions

on the part of NACA. Scientists and others have not had the free rein that they probably should have under NACA as compared to what perhaps a similar man would have had under the Office of Naval Research.

As I say, maybe I am in error on some of those positions. That is the thing that causes me to be concerned about the setting up of this new agency, if we propose to use, let us say, as an example or prototype, the NACA and then have an NASA to take its place.

I believe your statement in answer to one of the other gentlemen indicates you would not object to seeing a commission instead of the proposal in the bill.

Dr. YORK. That is where my experience lies and I am convinced that is a good way to do things. That is a positive statement about the Commission rather than a negative statement about the Advisory Committee.

Mr. SISK. I appreciate that.

Mr. O'BRIEN. You obviously feel that basic research has not been stifled when it has been performed under the military tent.

Dr. YORK. I think sometimes it has. I did not mean to say it has not been stifled at all.

Are you referring to the answers I gave on the question of classification?

Mr. O'BRIEN. No. What I had in mind is the sentence you had in your statement. You said:

> Even when space was unpopular and something to hide under the table, the Department of Defense was active in studying its potentialities and had many small projects in being.

The point I am trying to make is that if it had not been for the encouragement of basic research by the military we would be in pretty bad shape today.

Dr. YORK. That is very true. On the other hand, there is always room for improvement, too.

Mr. O'BRIEN. I understand. A great many people think there is a conflict between the military and the scientist and that the military does not encourage the scientist. Obviously they have, from your own statement.

Dr. YORK. Yes. There are a lot of personal opinions on that. I do not feel that there is this conflict that some other people do feel there is.

Mr. O'BRIEN. Mr. Fulton.

Mr. FULTON. I am glad to see you here, Doctor. Obviously, under the appropriations system of Congress, for the military whatever basic research has been in the program has been smuggled under the table because there has been no money appropriated to these agencies in the military for that purpose.

Dr. YORK. Not for any specific purpose, but in the service laboratories there is always a certain amount of freedom allowed the better people to do some thinking of their own. That is where these things were born.

Mr. FULTON. But it was you people who made room for it in your budget?

Dr. YORK. Not ARPA. We are only a month old.

Mr. FULTON. I mean the military people.

Dr. YORK. Well, made room for it, yes, allowed it, whatever you want to say.

Mr. O'BRIEN. Bootlegged it a little bit, perhaps.

Dr. YORK. That term is sometimes used. No doubt in this field there was a certain amount of bootlegging.

Dr. FORD. If I may, I would like to correct the record. Out of approximately \$700 million appropriated in fiscal 1958 for research and development in the 3 services, I would venture to say that for the 3 services in accumulative total there is probably a minimum of \$200 million used in basic research, according to their own testimony.

Dr. YORK. It is hard to define "basic research," of course. It is like the question: Who is a liberal? You can't settle that question.

Mr. FORD. Yes, but there is a considerable amount of money and a sizable number of projects which could legitimately be called basic research. It is not as much as the military would want for basic research and, certainly, not as much as the scientists themselves want, but there is ample testimony in the hearings over the last few years that a substantial portion has been used in basic research in one sort or another.

Dr. YORK. Yes; there is a considerable amount. There is always room for improvement, but there is a considerable amount.

Mr. FULTON. I think we want to see the military have an opportunity for basic-research programs in their programs that are, under the proposed legislation, restricted primarily to military weapon systems.

Dr. YORK. We in ARPA are looking into the question of in what area is there too little in the way of research and are beginning to identify some and hope to get on with them.

Mr. FULTON. That is why I asked you, in connection with the gentleman's question, for better language to assure that just this thing will be taken care of in the future.

Dr. YORK. I am not enough of a lawyer. I could interpret it in such a way that would make it broad enough now, but I suppose somebody else could do it some other way.

Mr. FULTON. You have projects on the shelves of ARPA now that you believe are practical. How many projects, in number or size, are there that are sufficiently practical so that, if you had the ability to go ahead with it and instructions to go ahead, you could do? Are you being held back much on the plans and programs you have because Congress and the American people are not being awakened to what you are going?

Dr. YORK. I think, right now, we are probably being held back, if it is fair to say we are being held back. There are two reasons.

Mr. FULTON. You would say that, first, you are being held back in ARPA?

Dr. YORK. Or we are holding ourselves back. We are very new. We are still getting our people. As far as the ARPA staff is concerned, we now have one kind of string or another on what we regard as a sufficient staff for going ahead, but they are not here. It will take some time for us to get them here. It will take some time for us to get oriented. One of the reasons we are being held back is the fact that we are very new and are still trying to develop our capability.

Mr. FULTON. Take, for example, the million-pound-thrust engine. You could be expanding your studies tremendously on that if you had $15 million to $25 million to begin with, instead of $500,000 annually.

Dr. YORK. Yes.

Mr. FULTON. Is that not right?

Dr. YORK. That is quite right. The other thing holding us back is that, since there was no ARPA at all, it was hard to appropriate money to ARPA, and there was $10 million appropriated in fiscal 1958.

In the next fiscal year, there is around a half billion dollars, but the fiscal year does not start for 3 months yet. So, we are held back, if you like, both because we are new and don't have people, and, also, because we are new and don't have a fiscal 1958 appropriation.

Mr. FULTON. The question is: Do you have room to put in your budget the research that is necessary for lunar shots, million-pound-thrust engines, a third-of-a-million-pound-thrust engines, ion propulsion, photon propulsion, nuclear propellents?

Dr. YORK. We don't have room for everything under the sun, but we have room for most of the things you mention. We do have room for a million-pound engine. We do have room for lunar problems and so forth.

Mr. FULTON. Do you have room for the development of this intercontinental travel and this intercontinental capsule freight transmission or the shot proposed by Von Braun to put a man 150 miles into the air?

Dr. YORK. We can do some combination of these things.

Mr. FULTON. Which would you leave out?

Dr. YORK. I am not prepared to answer. For instance, several of the things you mentioned have to do with what we refer to under a general title of "Man in Space." What we intend to do jointly with all 3 of the services and with NACA is to study the some 60 proposals that have been made for "Man in Space."

There are not really 60 different proposals, but there are a half dozen which are different. We propose to study those, review them, try to see which ones make the most sense with respect to such items as time scale, cost, pertinence to long-range objectives, reliability, and so on, and then institute a program to get a man in space. There are quite a few alternatives for the short term. You mentioned Von Braun's proposal on what is called the Adam program. That is the flight of two men in Redstones.

Mr. FULTON. I think it has been renamed, since this committee started, "The Woman Being Shot From the Gun" program.

Dr. YORK. Perhaps so. The last name I am familiar with is the Adam program. This has to be evaluated against other ways of finding out information.

The question comes up: Which ones are more pertinent in the long run?

The Adam program does put a human being into space, but it only puts him in for a very short time and, as it is proposed now, only two.

The alternatives to that sort of thing are, first, to put animals into orbit and study both the psychological reactions of animals, and for

a much longer time. Animals being lighter than men, they can be put into orbit much sooner than man can, simply because the capability for putting them up, that is, the requirement for thrust, is less.

Also, of course, the requirement for safety is considerably less, too. Of course, we do not necessarily have to choose between one or the other. It is possible to do them both.

Mr. FULTON. Our point on this committee is that there are some of us who want to go ahead with a space program on an accelerated basis and on a much broader basis, first, for security, and second, for exploration, and, third, to encourage the tremendously expanding space industry. How do we do it? We want you people to think broader, and maybe Congress, itself, will raise its sights.

Dr. YORK. Incidentally, I would hope that there would be more money for space matters next year than there is just in the ARPA budget. I would hope that NASA would have a sizable budget of its own for carrying out programs that are primarily civilian on its own and to combine with funds of others for programs that might be of joint interest.

The CHAIRMAN. Assuming you have the money, what kind of space program do you see for ARPA?

Dr. YORK. ARPA has not tried to lay out a complete national space program because the NASA, presumably, is coming along. Roughly speaking, the space program that we have laid out consists of, first of all, the things already going on. There are 4 space vehicles that we authorized for ABMA, including 2 lunar probes. There are the three lunar probes we have authorized for the Air Force Ballistic Missiles Division.

These are nonmilitary in objective. In addition, as a continuation of that, we hope, in conjunction with requirements and priorities established by the National Academy of Sciences and the National Science Foundation, and the NACA, to set up a continuing program of some reasonable number of scientific space vehicles per month.

I don't know what is reasonable yet because on the scientific side the Academy people and that group have not yet really made a positive indication of what they think there ought to be.

We are still in the process of trying to find out what the costs are to put one up. We don't know the number of satellites per dollar and so forth, but I imagine one per month or every month for purely scientific purpose might be a reasonable number.

Mr. FULTON. How can we in Congress on these space programs increase the proportion of thrust to drag? How can we get it moving faster?

Dr. YORK. Well, pass the 1959 budget, I guess, is the first item.

Mr. FULTON. Would you put in the record your method of deciding jurisdictional disputes at present between ARPA and the NACA, the policies you are using?

Another thing is this: Supposing this committee recommends the establishment of an agency, a separate agency in Government, to have the primary responsibility for implementing a glossary or dictionary of scientific terms that will be official for the whole United States Government, where would you put that?

Dr. YORK. A glossary of scientific terms that would be official?

Mr. FULTON. Where would you put the agency? Who should do it?

Dr. York. I do not really much care. If you want it done right now, it has to be done within the Department of Defense probably.

Mr. Fulton. Should there be a separate division of NASA to do that or should it be over in the Library of Congress?

Dr. York. I don't think it is that type of job, a separate division of anybody. You can get a couple of people together who know these terms and then they can go around and ask more people, "What should you like to put in here?"

Mr. Fulton. But it should be done, should it not?

Dr. York. Well, I suppose. I don't even get excited about it.

Mr. Fulton. I have heard scientists use terms here that do not equate with the other scientists' use of terms. For example, I heard one of them use air for atmosphere and atmosphere for space.

Dr. York. I am sure it is worthwhile. I just am not very personally excited or interested. I am sure it is worthwhile.

Mr. Fulton. On this translation of documents from foreign countries, should we have a special agency set up by this committee in Government to have the overall responsibility for the Government and every agency in it for making translations on space and basic scientific research materials?

Dr. York. Certainly such translation should be made, indeed. I do not know whether this committee should get into it or not. It could be handled either by the NASA or we in ARPA could find somebody to handle it.

Mr. Fulton. I was really asking you what agency should handle it rather than whether any congressional committee should handle it.

Dr. York. Well, it could be handled by the Science Foundation or there are quite a number of groups interested in the translation of scientific documents at this time.

The Science Foundation is one group. ONR is another. In a particular field like this the NASA could do it.

Mr. Fulton. I understand that the Library of Congress at present is not able to keep 1 out of 6 volumes it would like to keep in related fields, the fields we are discussing on space. So should that not be expanded?

Dr. York. I think it probably should.

Mr. Fulton. How do you make available generally, to the companies participating in these programs the materials that would be of a scientific nature which would help them on their contracting?

Dr. York. You mean information?

Mr. Fulton. Yes. How could we get a system of distributing that around the country, particularly in relation to small business.

Dr. York. I really do not know how to do that.

Mr. Fulton. You see, so much of it is classified that it keeps many small businesses out of the program.

Will you submit a statement on the record for that?

Dr. York. I don't know how long it will take me to submit a statement on that.

Mr. O'Brien. Dr. York has to get a plane at 6. I understand in spite of scientific accomplishments, to get to the airport you still depend on gasoline propulsion?

Dr. York. Yes, sir.

The CHAIRMAN. Doctor, in response to my question on the space program conceived for ARPA, I don't think you completed your answer, on the rest of the ARPA program.

Dr. YORK. Yes. I had discussed essentially the programs we had already specifically authorized and then the fact that we are working on a continuation of such a program.

The CHAIRMAN. Can you give us an idea of what that continuation is?

Dr. YORK. I mentioned perhaps one a month or perhaps every other month or something like that. We do not yet have a picture. We don't have, yet, what you might call a requirement from the IGY or the people who will follow the IGY.

In addition to that, we are planning component development programs. The million-pound-thrust engine is one such component development program.

The development of special stages to go on top of our big rockets is another. That is, as has been pointed out here quite a few times, it is not just the matter of a thrust in the bottom stage, but it is what goes on top, too. So we are planning development programs on having better higher performance, higher stages for rockets as well as developing larger lower stages.

We are planning development programs in special components of other sorts; that is, better telemetry systems, better power supplies.

There are a great variety of power supplies for use in space. Both chemical batteries and solar batteries are now being used but both of those can be improved.

There are also reactor power supplies, there are radioactive isotope power supplies, there are solar boiler power supplies and so on.

We are planning a review of that field and then initiation of research and development in various and sundry power supplies suitable for space.

Various new guidance and control systems for midcourse and terminal guidance in connection with getting into precise orbits are being planned.

You know the satellites that are now in orbit are in orbits that are very inprecise, big loopy elipses that are not nice circles and so forth.

We are planning developments of components of that sort. Then we plan again to first review requirements and review the possibilities in a group of possible fields of application, practical application of space.

The ones that were mentioned several times this afternoon, I am sure, communications, meterology, weather reporting, navigational aids, things of that sort, which are of military interest as well as civilian interest, and in many cases the military interest is different from the civilian interest.

You might have satellites which are not just simply relays. I mean one way of having a communication satellite is to have a satellite at some very high altitude, perhaps the one that stands still, use it by simply beaming up and receiving radiation back. That is one possible kind of satellite communication relay. That obviously is not very secure, I mean, anybody can hear what it says.

You could, of course, code it, but anybody could hear it.

Another kind possibly is the one that is sort of like the mailman that has been discussed here, too, where you put information in it at one point and it goes over another one and then you take the information out.

In connection with meteorology, the military interests are different from the civilian interests. The military is always interested in such matters as strike information, for instance, and in connection with the possibilities of nuclear war would be interested in the question of which way the wind is blowing in the target for fallout prediction purposes and so on.

Other programs and actually bigger programs, but programs which I think we should not discuss here, considerably bigger programs, are programs in the use of satellites for strictly military purposes, early warning reconnaissance and so on.

One of the things incidentally in all of the discussions that makes it look as though the civil program is where all of the interest lies is because you cannot talk about the military program. But it is a sizable program. That part of the iceberg that is under the water is the large part.

The CHAIRMAN. Is biological and chemical activity involved?

Dr. YORK. Man in space is a part of the program that we hope to get going. That includes biology, but of a rather special sort. There are really two almost independent branches of what you might call space biology.

There is one which is the human reaction to space, which is important for human space flight, I mean the physiological and psychological reactions of man to weightlessness in particular and acceleration on the way up and perhaps environmental problems. But I think the weightlessness is the overwhelmingly important one and the other biology, the regular biological research where you investigate the organisms under weightlessness where you go to see if there is life on Mars and things of that sort.

These are not of direct military interest. They are not necessarily of interest in connection with military applications.

They might very well become interesting. Nearly any kind of research can lead to results which are a defense interest.

Now, I think I have covered this especially by putting in that big miscellaneous of the special military program.

Mr. FORD. I happened to have heard Dr. York before another committee yesterday and I will forego questioning because of his time problem.

Mr. O'BRIEN. We all appreciate your time problem. We are very grateful to you, Dr. York, for your contribution to the record.

The CHAIRMAN. Not only his knowledge, but his simplicity as well.

Mr. FORD. May I make a suggestion, Mr. Chairman?

Dr. York, is there any objection to the insertion in our record of this chart you submitted to us yesterday showing the organization of ARPA?

Dr. YORK. No, sir.

(The chart above mentioned faces p. 60.)

The CHAIRMAN. I have one more question

In the line of command in ARPA in connection with the Defense Department, are you finding a pleasant, cooperative, understanding, fertile atmosphere, whatever you want to call it?

Dr. YORK. Yes; so far, so good. It is still a somewhat new situation but it shows promise of working well.

The CHAIRMAN. Do you run up against lines of resistance in going through too many steps to get action?

Dr. YORK. Sometimes, perhaps, it seems that way, but then one must recall that ARPA is brand new and nobody over there knows whether we can really be very effective or not.

So it is very natural to expect that people are looking over our shoulders at the present time. But it looks to me as though it will be a situation that will work out very well.

The CHAIRMAN. We know about the difficulties in bygone years. I was on a subcommittee that looked into research and technology in the Defense Department back in 1954. There are a lot of equations in human beings but sometimes they are exaggerated to a harmful extent.

Have you found that has been corrected to some extent?

Dr. YORK. Of course, I do not know how it was. I do not know as well as you do how it was. I have been in and out of the Defense Department in the last few years.

I don't know if it has been corrected or not. However, I do have a good degree of confidence, speaking personally, that things are moving in the right direction over there.

Mr. O'BRIEN. Again, thank you, Dr. York.

The committee will meet tomorrow in room 219 in this building at 10 a.m.

(Whereupon the committee recessed at 5:10 p.m., to reconvene at 10 a.m. Friday, April 25, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

FRIDAY, APRIL 25, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS,
AND SPACE EXPLORATION,
Washington, D. C.

The committee met at 10 a. m., pursuant to recess, in room 219, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack, Brooks, Hays, Metcalf, Natcher, Sick, McDonough, Fulton, Keating, and Ford.

Present also: George J. Feldman, director and chief counsel

The CHAIRMAN. The committee will be in order.

We are very happy to have with us three distinguished gentlemen this morning as witnesses. The first witness is Dr. Clifford C. Furnas, chancellor of the University of Buffalo.

Doctor, we are very happy to have you with us. Have you a prepared statement?

STATEMENT OF DR. C. C. FURNAS, CHANCELLOR, UNIVERSITY OF BUFFALO

Dr. FURNAS. I am sorry, Mr. Chairman, I do not have a prepared statement.

The CHAIRMAN. All right. Everything is informal. I like informality in committee hearings rather than formality. You may proceed in any way you want. As far as the committee is concerned the more informal it is the better we like it.

Dr. FURNAS. Thank you sir.

The CHAIRMAN. We shall be glad to hear you, Doctor. By the way, each one of the witnesses will have the opportunity of editing his testimony. You may clarify or add thereto or, if upon reflection, you think of something that you feel might be helpful to the committee in its hearings that you did not cover in your testimony or under questioning, you may include that in your revised remarks.

All right, Dr. Furnas.

Dr. FURNAS. Mr. Chairman, ordinarily one gives a biographical statement at the beginning of the testimony. I might say that I was for a period Assistant Secretary of Defense for Research and Development, from November 1955, to February 1957.

If it is satisfactory with you, Mr. Chairman, I will simply leave a biographical statement for the record and then proceed.

(The record is as follows:)

Brief Biography of Dr. Clifford C. Furnas, Chancellor, University of Buffalo

Dr. Clifford C. Furnas was born October 24, 1900, at Sheridan, Ind. He holds the degree of bachelor of science, with honors, from Purdue, 1922; of doctor of philosophy from the University of Michigan, 1926; and of honorary doctor of engineering from Purdue, 1946; and from the University of Michigan, 1957. While in school he was a long-distance runner of distinction, and competed in the 5,000 meter event at the Olympic Games in Antwerp in 1920. In 1922 he was awarded the Big 10 Conference medal for the best combined scholastic and athletic record.

He has always had a sustained interest in both research and education and his working career reflects this duality. From 1926 to 1931 he conducted research work on metallurgical processes at the United States Bureau of Mines at Minneapolis, Minn. In the latter year he joined Yale University as associate professor in chemical engineering. In 1941 and 1942 he worked for the National Defense Research Committee, coordinating a large research and development program. He was appointed by Curtiss-Wright as director of its aeronautical research laboratory in Buffalo in February 1943. This laboratory was given to Cornell University on January 1, 1946, and he became director and executive vice president of Cornell Aeronautical Laboratory. He assumed the post of chancellor of the University of Buffalo, September 1, 1954. On December 1, 1955, Dr. Furnas was granted a leave of absence by the university to serve as Assistant Secretary of Defense for Research and Development in Washington, D. C. He returned to his University of Buffalo post, February 15, 1957. For a number of years he has been an active member of various technical boards and panels for the Government, particularly in the Department of Defense.

While Dr Furnas has conducted a great deal of research in the fields of process metallurgy, he has specialized in and has written many technical articles on chemical and chemical engineering subjects as well as on phases of research related to aviation. In addition to technical and educational articles he has written several books, including America's Tomorrow (1932); The Next Hundred Years, a Book-of-the-month Club selection in January 1936; Man, Bread, and Destiny, written with his wife, S. M. Furnas (1937); and The Storehouse of Civilization (1939). He was editor of the sixth edition of Roger's Manual of Industrial Chemistry (1942). He was also editor of the Industrial Research Institute monograph on Industrial Research—Its Organization and Management (1948).

He is a member of Theta Chi, social fraternity, various honorary fraternities, social clubs in New York and Washington and of several scientific and engineering societies. He is a registered professional engineer in the States of New York and Connecticut.

Mr. Keating. I might add at that point, Mr. Chairman, that we in western New York are very proud to claim Dr. Furnas from our neighboring city of Buffalo. It is almost surplusage to include a biographical sketch of such a distinguished American.

The Chairman. The sketch is only necessary for the record. If I were a judge and you were appearing as an expert witness you would qualify without the necessity of establishing proof.

Dr. Furnas. Thank you, Mr. Chairman.

In lieu of a prepared statement which I simply did not have time to put together, I thought I would excerpt some material from a talk which I am going to be giving to the Air Force Office of Scientific Research Symposium on Astronautics in Denver, next Monday.

With your indulgence I would like to go a little bit into my own background thinking in approaching the matter of an appropriation for space exploration. I hope it does not seem to be extraneous.

So if I might proceed with some excerpts from this talk:

Why go to the Moon, or Mars, or Venus? At the present time there are probably five good reasons. Arranged in the order of prominence in the public mind, they are:

1. International prestige.
2. Possible military advantage.

3. The spirit of adventure.
4. The possibility of practical technical advances.
5. The thirst for knowledge—the desire to learn more about the cosmos.

This is not necessarily the most logical or most virtuous order of importance, but I believe the list does represent the present relative rating which a public opinion poll would reveal.

Whatever may be the impelling reasons, it now appears quite certain that, within the next few decades, man is going to explore space—at least within the solar system—very assiduously.

The United States space program will not only be complicated. It will be expensive. Now that we are faced with it, three questions come to mind:

I. Is there real justification for that support?
II. How should it be organized?
III. What will be the long-time results?

The first question, Can continuing support be justified? My remarks on this are tying in the military activities with the possible byproducts for civilian benefit. May I present a little bit of background on the byproducts of military activities.

Despite the destructiveness of wars, military activities have often, though sometimes inadvertently, led the longstanding human benefits.

Until the end of the 18th century mechanical goods were fabricated on an individual basis. Each item was practically custom built. In 1800 Eli Whitney (inventor of the cotton gin) obtained a contract from the United States Government for a substantial quantity of muskets.

After a full quota of difficulties, he produced them at his little water-driven mill at Whitneyville, Conn., with truly interchangeable parts; and he effectively reduced the technique to practice.

This was the necessary and sufficient background for the establishment of the mass production of duplicate mechanisms. Be it noted that this step, which was one of the key landmarks of industrial civilization, was born of a military need.

I can mention many others. For instance, the conquering of yellow fever, because of the work in the Army of Maj. Walter Reed; the fixation of nitrogen by the Germans immediately preceding World War I which is now our source of artificial fertilizers which keeps the world from starving to death; and the invention of the airplane would still be just a rather interesting device were it not for the support of the military throughout the last 40 years.

Had it not been for the support of the military for military purposes we would even now I am sure not have safe commercial aviation. Coming to World War II, the great acceleration which was given to the production of antibiotics, particularly penicillin, was one of the things caused by the war needs and has been of benefit, of course, to hundreds of millions of people.

There was a somewhat similar development in the form of synthetic rubber, although synthetic rubber was highly unsafe until the mass production method for making it was developed during World War II because of military necessity.

Then, of course, radar, which has a tremendous amount of civilian application, was the result of war activities, and then most striking of

all is the nuclear energy which arose from the military aspects of the atomic bomb.

I might add, perhaps parenthetically, it is fortunate in the 20th century we did begin using atomic energy for destructive purposes because it is my opinion the only way we will be able to supply the necessary energy for the world by the year 2000. Had we not done this in the middle of this century we would be in a very difficult situation throughout the world some 50 years from now.

The CHAIRMAN. Why do you make that statement?

Dr. FURNAS. Because in 50 years from now the world is going to need, and hence demand, manifold as much energy for the industrial production as we have now, and it is not going to be supplied by our fossil fuels—coal, oil, and gas. Perhaps I am wrong by a few, but not many, years.

Now these few examples from scores of possible ones leave no doubt that military developments have in the past led to many profound peaceful benefits and can well continue to do so in the future, even at an accelerated pace—if we but put our minds to the task.

Such byproduct benefits are one of the uses of adversity. If the national research and development program is planned and carried out with the secondary public benefits in mind, large continuing expenditures are well justified, no matter what may be the course of their national events.

Moreover, the program will make sense to the public, and the public will be willing to provide all reasonable support. The second question, What should be the organizational pattern?

The dual structure of military and civilian participation in affairs dealing with national defense has been fundamental in our national organization from the beginning. It is a sound pattern, but it does have its difficulties and its points of indecision. One of the debatable points is always: Should a particular activity be under military or civilian control? That question is now being debated in connection with the research and development program for the exploration of space.

In 1915 the NACA (National Advisory Committee for Aeronautics) was established to aid and advise the Nation in the basic and applied aspects of the then infant science of aeronautics. It was an entirely civilian agency. It has always remained so, even though a very large proportion of its work has been directed toward military applications. It has worked very well indeed. Its impact on both civilian and military aviation has been profound and outstanding.

The Atomic Energy Commission is a similar case. Although, immediately after the end of World War II, the paramount interest in the atom was for military purposes, it was realized that nuclear science would, and should, have impact and importance in many nonmilitary areas.

Hence, after considerable acrimonious debate, the AEC was established as a purely civilian agency. After appropriate liaison and coordinating bodies were set up between the military and civilian facets, it, too, has worked very satisfactorily. Should the same pattern be followed for the exploration of space?

The present proposal which is being considered by Congress is for the establishment of a National Aeronautics and Space Agency, which

is to be the focal organization for research for both military and civilian space projects.

This new organization would absorb the present National Advisory Committee for Aeronautics. I can best summarize my own reaction by saying I think this is an excellent idea. The scientific competence and administrative structure of the NACA is a most appropriate base from which to build the expanded activity. Such a move avoids setting up a large new governmental agency of which there are already quite enough.

The operating pattern and tradition of NACA practically insure effective coordination and cooperation with the Military Establishment. At the same time, civilian interests will be handled sympathetically and will receive adequate attention.

Discussions of the establishment of a new agency always proclaim an open season for objections and suggestions. I would like to make my contribution with one suggestion on what I believe to be a significant matter. I believe it is most important that this new agency, the NASA, should, as compared to the NACA, have expanded authority and liberalized policies for the support of research by outside agencies.

Certainly scores of excellent research laboratories in universities, research institutes and some industries should be supported by contracts in contributing research knowledge to the multiheaded problems of space.

If this aspect is not adequately handled, the national program will be greatly weakened. There is always the tendency, even if not the intent, for large Government organizations to become monopolistic. This tends to freeze out great blocks of talent, new ideas, and appropriate competition. Further, it seriously shrinks the reservoir of manpower from which future research talent can be drawn. I trust that adequate attention will be given to this important matter.

The CHAIRMAN. Have you looked into this provision of the bill from that angle?

Dr. FURNAS. I have not.

The CHAIRMAN. Will you do so?

Dr. FURNAS. I shall.

The CHAIRMAN. I think the language might cover it; but, on the other hand, I think you are addressing yourself to a point that I know meets response from me. In fact, I have considered that before. Now it is going to be really an operating agency.

It is quite a transformation, according to the concept of the bill. That is true, is it not?

Dr. FURNAS. Yes.

The CHAIRMAN. I think the point you have made is well taken. I would like you to examine the bill to see if the language is adequate to meet that situation.

Dr. FURNAS. I shall be very glad to do that, sir. If this new agency, the NASA, is established, how far should the Military Establishment be permitted to conduct or support research of more or less fundamental character in the general field of space technology?

Some very old arguments are being dusted off and put out on display. There are those who feel that the military organization should stick very closely to its knitting and only develop military hardware; that it should not broaden its operations to encompass anything

resembling fundamental explorations. There is still considerable feeling that it is not appropriate for the military to dabble in "scientific toys."

I feel that such arguments get the cart before the horse. If there is even a small probability that military weapons systems now or in the future are going to need some block of fundamental scientific information, which is not now being adequately sought for in some other quarter, then it is incumbent upon the Military Establishment to see that that general area is being adequately explored.

The exploration of space with all its ramifications, will unquestionably be an expensive, as well as a difficult, task. It is incumbent upon all concerned to husband the financial and the scientific resources as much as possible. This is going to make it even more necessary than ever to achieve a truly adequate coordination between the military and civilian programs.

The proposed reorganization of the Department of Defense, which also is receiving congressional consideration, can be a key factor in achieving the desirable pattern of action. President Eisenhower's statement that "separate ground, sea, and air warfare is gone forever" certainly has validity. It also points up the necessity of taking a good hard look at the organization, for all the military functions.

I would not presume to pass judgment upon the proposed changes in the operating command structure, but I do feel that the anticipated changes in the research and development area is a good step in the right direction. There are two important aspects of the proposed reorganization. First, the official in charge of the overall program (the Director of Research and Engineering) will have a higher rank and more well-defined authority than the present Assistant Secretary of Research and Engineering.

Second, this official will have at his command and available, certain funds and transfer authority which will permit him to initiate and control important research projects, particularly those which are of potential benefit to all three military services. This will give him a positive and constructive control which has been almost completely missing in the Assistant Secretary's Office in the past.

At present, the Assistant Secretary effectively has only negative control. The situation is roughly analogous to being responsible for driving a car but having access only to the brakes and not to the wheel and the accelerator. That is not a very satisfactory way to drive a car.

There are those who fear that the proposed structure will lead to too much concentration of power and that the desirable amount of competition among the services will be lost. Admittedly, a certain level of competition is desirable, but not the mayhem which is what we have been exposed to for quite some time. Even a football game needs a set of enforceable rules and an effective referee.

One of the major responsibilities of the new Department of Defense Research and Development organization, if it does materialize, will be the adequate planning and coordination of those projects dealing with space technology which can be carried out either by civilian organizations or the Military Establishment, or both.

This will be a difficult task at best but it can only be carried out effectively if there is adequate and well-defined authority, as well as responsibility, in the Office of the Secretary of Defense. Orderly

planning and procedure is going to be much more important than ever before.

The third question: What will be the longtime results?

Who could have predicted what Columbus would find when he sailed westward in 1492? By comparison, while we must admit that part of the crystal ball of space exploration is very cloudy, there are a few things which can be predicted with reasonable certainty.

It is reasonable to expect that before long we will have reconnaissance conditions, either manned or unmanned, which can continuously communicate a great deal of information about conditions on all parts of the surface of the earth. The military utility of such reconnaissance satellites is obvious.

It is also reasonable to expect that such satellites can be useful as practical relay stations for short wave communications over long distances. The development of anti-ballistic-missile missiles is very closely linked and perhaps should be an integral part of the space program. There can be no question of these military needs.

On the other hand, I find it impossible to generate any enthusiasm for the idea that artificial satellities, or the moon, could be militarily useful as storage places and launching platforms for guided missiles. Conceivably this might be possible but it would be the hard way to accomplish the military objective. Why do it?

If we should become thoroughly bemused with difficult accomplishments such as that, we could fritter away endless amounts of money and scientific talent. We will soon have guided missles of long range and great weight-carrying capacity which can reach any spot on the earth with far greater accuracy and infinitely less expense than any launched from artificial or natural space stations. Perhaps it is a sign of advancing age, but I do feel that enthusiasms should be tempered with a certain amount of judgment, particularly when very great sums of money and effort are involved.

Even though the space program has a very strong military impetus, the greatest yield in the long run may very well be from the indirect results. It will be difficult to predict what the applications may be; whether their greatest impact will be military or civilian. But, we can be quite sure that a number of things will be forthcoming. New knowledge nearly always finds a use—eventually.

One can visualize many developments in propulsion, especially in the field of rockets. Many basic and applied research programs are underway in the development of new fuels of greater energy content and greater specific impulse than the conventional hydrocarbon fuels. Various oxidizers for rockets are also under intensive investigation.

Since the conventional fuels and oxidizers, such as jet propulsion fuel and liquid oxygen, are marginal in their performance for getting into space, there will be greatly increased emphasis upon the development of the more exotic substances. The boron fuels which are under development for possible use in turbojets or ramjets do not offer any particular advantage in rockets, but these are by no means the only possibilities.

The most attractive fuel, of course, in terms of energy per pound, is liquid hydrogen. But its use is plagued with many practical difficulties. Its density is so low that it is very bulky, indeed. The very low temperature of liquid hydrogen leads to endless difficulties. It is hazardous to handle, unless extreme care is taken. These are

the kind of difficulties, however, that intensive development may be able to overcome. Fluorine has some distinct advantages over oxygen as an oxidizer. It, too, is a nasty substance to handle. But here again, intensive development may lead to practical solutions for its use.

Sketchy and preliminary measurements have established that the very nebulous atmosphere about 60 miles above the surface of the earth contains substantial amounts of monoatomic ionized oxygen. Oxygen molecules are ordinarily diatomic but in the rarefied high atmosphere the energy of the sun causes them to dissociate into single, ionized atoms.

When such atoms recombine, they release very substantial amounts of energy. Hence, studies are going forward on the possibility of using this atomic oxygen supply as the fuel for a ram-jet flying at those altitudes, at high speed.

This fuel supply would be inexhaustible so a ram jet propelled in such a manner could go on flying forever at this altitude, or until it wore itself out. The air at that altitude, of course, is extremely thin, the pressure being only about 3 millionths of an atmosphere.

Hence there is not very much atomic oxygen fuel per cubic foot and hence the thrust from such a device would be very small. However, the drag would also be very small and calculations indicate that such a ram-jet machine could fly, although it would have to be very light in weight. We need to learn more details about the condition of the atmosphere at those altitudes and then we need to try to get one of the devices up there to determine if it will fly as the calculations indicate it should.

Would this system have any practical advantage for either military or civilian use? Of course, we don't know. But, undoubtedly, we would learn a great deal. The knowledge would be applicable to research on free radicals of various substances that have some high energy fuel possibilities. Free radical research is one of the most interesting fundamental investigations that is going on at the present time.

Research in the development of nuclear rockets has been proceeding at a low level. This program, with the investigation of space in mind, will undoubtedly receive renewed emphasis. The first developments will be with nuclear rockets carrying some sort of a fluid to produce thrust. This will be necessary in order to develop the high thrust necessary to launch a device from the earth and accelerate it to very high speeds.

The second phase of the investigation will involve the thrust which may be developed from a nuclear rocket using only the nuclear particles of the active fuel itself The amount of thrust so produced would be very small but it could be long sustained. Perhaps this will prove to be the only effective way of developing adequate acceleration for true space travel. Will such developments have military or civilian application? No one can say with certainty but the chances are that they will.

There is a very good possibility that efforts such as these will, in the not distant future, lead to practical, rocketship transportation of men and materials between distant spots on the earth's surface. When that day comes, every spot on the earth will be within 2 hours'

traveling time of every other spot. This will be a tremendous step in man's advancement.

One can visualize a number of developments of new component devices which will eventually find great utility. One of the American satellites now orbiting overhead is using solar batteries of a new type to power its milliwatt broadcasting station. Solar batteries are in their infancy and space exploration is going to lead to their great improvement. One can visualize many applications which may be far more significant than merely powering portable radios.

Another approach to the satellite power supply for sustained instrumentation and broadcasting is the development of very small, compact, and effective nuclear powerplants. When such devices are perfected, will they have utility outside of satellites? They probably will.

Already many advances have been made in very compact and lightweight electronic instruments of various kinds in connection with the satellite program. The possibilities of utility here are very great, indeed.

Our thinking, however, would be very restrictive, if we simply confined ourselves to trying to visualize the immediate development of practical devices.

In the long run, the most appealing part of the exploration of space will be the acquisition of new, basic knowledge. One of the more intriguing fields of investigation is that of the terrestrial weather. What effect do the violent storms on the surface of the sun, and the sunspot cycle, have to do with the weather over the surface of the earth? It seems quite apparent that there is an effect, but how much and why? Do the ever-shifting magnetic fields around the earth and around the sun have some impact, particularly on the long-range weather cycles? When we acquire more fundamental knowledge about the solar and the terrestrial weather and their relationships, we will certainly be able to make better predictions which will be useful to a great many people.

If we are able to improve our predictions, will we eventually be able to control the weather if we should so desire? It is highly important that we try to arrive at the answer to that question.

Even now, very early in the game, our quite small satellites have yielded considerable new data on cosmic rays, those rather mysterious high-energy radiations which constantly bombard us from outer space. Just what are the makeup and the characteristics of the primary cosmic rays? Where do they come from? What do they signify? Some have said that they are the birth cries of atoms; others have said that they are the death cries of atoms.

Perhaps they are both. Be that as it may, these fringes of outer space constitute one of the most effective laboratories for the study of nuclear phenomena, provided we can get adequate experimental apparatus there and maintain it. Directly, and indirectly, we are going to learn a great deal more about the fundamental structure of matter and what the nucleus really is and how it acts.

As a Cornell professor recently stated it, "Researchers studying the source of cosmic and radio waves in space and those trying to produce controlled nuclear power are traveling the same scientific wavelength." Such knowledge may turn out to be the key to the effective and practrol of fusion (the hydrogen bomb reaction). When and if this

occurs, we will have found the way of supplying essentially an infinite amount of energy for human use on the face of the earth, for all time to come. We trust that it will be used for peaceful purposes.

Although I can see no reason for attempting to use the moon as a weapon carrier, I think it still might be very useful to us. Some day we will get there. It would make a marvelous stable platform, without any interfering atmosphere, for an astronomical observatory. If such a station could be established, the results would add greatly to our knowledge of the universe; how it is put together and how it ticks.

It would be very interesting, indeed, to have some solid samples from the moon. They won't consist of green cheese but they might be just as palatable to scientists. We might learn something new about the evolution and the concentration of minerals.

If we should get to Mars, and if there is plant life there as many people believe, we would add greatly to our knowledge of the penomena of living matter itself. If there is life there, it has certainly evolved under quite different atmospheric and other physical conditions than on earth. Would such new samples, which arose from very different conditions, give us some intellectual leads to common and basic phenomena of the chemical kinetics of living matter?

It is a very interesting speculation. When we do learn more about the basic facts of life, we almost certainly will make still further improvements in human health. It is not hard to visualize many other applications which ultimately will improve human welfare, when the living cell is no longer a mysterious and misunderstood blob of matter.

I want to summarize by saying that for our own immediate military welfare and for ultimate human advance it is highly important that we get to the moon and beyond.

The CHAIRMAN. Doctor, the bill provides for an organizational setup under a Director, as you know. Have you any opinions to express as to that type of setup or Commission type?

Dr. FURNAS. I am not sure I understood you, sir, as contrasted to having it under a Director or under a Commission?

The CHAIRMAN. Yes.

Dr. FURNAS. In general I feel this type of setup should be under a Director, that there should certainly be a guiding body very much as the present National Advisory Committee for Aeronautics.

It is that sort of structure which I think works very well.

The CHAIRMAN. The future field and jurisdiction of this Agency is broader as it is now and as it has been in the past; is it not?

Mr. FURNAS. The so-called NASA will have a broader field, yes.

The CHAIRMAN. I am exploring and trying to get the benefit of your views.

Dr. FURNAS. I do think the NACA structure has worked so well that it is one that can be used. Perhaps there will be some variations, but I feel the new structure should be modeled after that.

The governing board or the committee itself, which certainly guides the program, is made up of representation of the various key spots in the Government and also of outstanding national figures in the scientific field.

I think this makes a very sound, nonpartisan, guiding body which works effectively. It depends, of course, primarily on the character of the men that are there, but I think we will get such high character of men in such a governing body in that area——

The CHAIRMAN. Unfortunately, Dr. Dryden made a statement that the suggestion of Dr. von Braun was more or less a circus stunt like shooting a lady out of a cannon.

Dr. FURNAS. I believe that Dr. Dryden was referring to the von Braun statement, that within a year they could send a man 150 miles into space and bring him back, something like that, and Dr. Dryden said this was rather like a circus stunt, we would not learn anything.

I tend to agree—I don't know that I would make quite as vigorous a statement as that, but I tend to agree with Dr. Dryden on that.

I don't think there is a point to doing this with all the hazard unless we can learn something. If it is valuable to impress the Russians, in this way, then let us do it on this basis.

The CHAIRMAN. Out of that could come an awfully lot of good, the manned vehicle. There could be an honest difference of opinion on that.

Dr. FURNAS. I think there is an honest difference of opinion.

The CHAIRMAN. In your opinion, you would not refer to it as a circus stunt?

Dr. FURNAS. I would not.

The CHAIRMAN. Some of us thought that looked into the mind of Dr. Dryden, and it was only a slight piece of evidence, but you judge a person's mind by what he says and what he does; some thought that the statement indicated that he did not have an appreciation of the maximum possibilities to which that example was directed.

Dr. FURNAS. Knowing Dr. Dryden quite well, I don't think I have any trepidations about his imagination and constructive approach. I think all he was referring to was the fact that this would be premature until we had a great deal more instrumented flights.

The CHAIRMAN. What do you think of this 17-man board established by law?

Dr. FURNAS. I think I had probably better read the bill before I express an opinion.

The CHAIRMAN. You read it over and you express your opinion when you are editing your remarks.

Have you given any consideration to the possible international aspects of this field, international law, the sovereignty of nations in the outer space?

Dr. FURNAS. I have given no consideration to that, no.

I know it is the sort of thing that can be very complicated. I do know that there are various people who have been trying to express legal opinions of all the implications. I feel that the old analysis of freedom of the seas and freedom of the air are not going to be applicable.

I have formed no opinion as to what the legal aspects may be in the international scene.

The CHAIRMAN. I realize that that is a matter of many years of consideration and study and probably trial and error and the development of a code of international law and conduct, but I can see the possibility of one nation hitting the moon and claiming the moon within their jurisdiction.

Dr. FURNAS. I presume the claim is not valid unless it is occupied, however.

The CHAIRMAN. Well, it is according to who the nation is. I take it from your testimony that you have in mind the necessity of the military considerations involved, having also in mind the world of today and as far as we can project our mind into the future.

Dr. VURNAS. That is correct, sir.

The CHAIRMAN. Furthermore, there is an interrelationship there, anyway, is there not?

Dr. FURNAS. There is, definitely.

The CHAIRMAN. Furthermore, we have to, above all else, do those things best in connection with our country in connection with its preservation. Everyone has to face that fact, does he not?

Dr. FURNAS. That is right.

The CHAIRMAN. You refer to a number of incidents, of where something started out primarily as a military inquiry and has produced great peaceful benefits to mankind. Do you think there should be close relationship between any new agency and the Defense Department and the Atomic Energy Commission?

Dr. FURNAS. Yes, sir

The CHAIRMAN. In fact, all other agencies but those two, in particular?

Dr. FURNAS. That is correct, sir.

The CHAIRMAN. That could be done by representation on this board if it is part of the law, but also through the establishment of liaison groups where there would be the constant contact with one another and an exchange of views.

And, above all, there have to be understanding minds everywhere that appreciate the overall consideration of the national interest of our country?

Dr. FURNAS. Yes.

The CHAIRMAN. Mr Brooks

Mr. BROOKS. Doctor, I listened with a great deal of interest to your statement. I rather liked your approach to this problem. You make a very interesting statement and at the same time it shows definitely that it has ample substance.

I also like the apparent admiration that you have for the National Advisory Committee for Aeronautics. I worked with that Committee, too, for many years.

Does your university have projects in the handling of which they come from the Advisory Committee for Aeronautics?

Dr. FURNAS. No, at the present time we have no project with the NACA.

Mr. BROOKS. Have you had any such and have you had any experience with the way in which they handled these projects?

Dr. FURNAS I was formerly, until 1954, director of the Cornell Aeronautical Laboratory in which we had a few projects, not many, but I had a great deal of contact with the NACA because when I worked as Assistant Secretary of Defense, I was a member of the NACA ex officio.

Also, everyone that is involved in this NACA are personal acquaintances because of the activities of the Institute of the Aeronautical Sciences.

So I know the members personally and I know their work quite well as I have been on the subcommittee dealing with the subject matter for over a number of years.

Mr. BROOKS. You think the NACA is a well managed, efficient operation?

Dr. FURNAS. Yes, sir.

Mr. BROOKS. And it goes after the particular projects that it has in mind in a proper and efficient manner; is that right?

Dr. FURNAS. Yes, sir.

Mr. BROOKS. You had that experience as a member of the NACA Board. Do we have anybody from the Defense Department now on the NACA Board?

Dr. FURNAS. I have forgotten the makeup at the present time. General Putt, I think, is still on the Board, from the Air Force.

Mr. Foote, who was Assistant Secretary for Research and Engineering, is on there.

At the moment I am not sure who is on from the Navy.

The Army is not represented.

Mr. BROOKS. There is no provision in law with respect to the requirement that someone from the Defense Department or each agency shall be a member of the Board?

Dr. FURNAS. I am not sure whether it is provision of law, or regulation of the NACA itself. These are ex officio positions.

Whether they have set up that structure themselves, or whether it is a provision of law, I am not aware.

Mr. BROOKS. At any rate, the Defense Department is adequately represented at this time on the NACA Board?

Dr. FURNAS. I personally feel, although there are others who don't agree, that the Army should be represented if we are going to maintain our three military departments' organizational structure.

Mr. BROOKS. That is the only department which is not represented?

Dr. FURNAS. That is correct.

Mr. BROOKS. Because you do not know what is going to come out of this Pentagon reorganization, it may not be represented on there after that shakeup.

Dr. FURNAS. But I feel very strongly that, whatever may be the structure, the Military Establishment should be adequately represented on this Board, whatever it is called.

Mr. BROOKS. I share that view with you, because the military has given great impetus to the NACA program in the past, has it not?

Dr. FURNAS. Yes, sir; very much so.

Mr. BROOKS. How do they handle these projects when they approach a laboratory or university for the handling of a project? Can you give us very briefly how the NACA approaches that?

Dr. FURNAS. It is a matter of writing a contract. It may arise either way. It may be from the director of the staff that approaches the university because they know it has certain competence, or it may be that they know the university applies to the NACA and states, "We have an area in which we feel we are competent and we would like to explore and have your support."

It is a rather simple procedure. There is a definite contract that is written and handled with the director's office.

Mr. BROOKS. The contract is with the university or laboratory, not with the individual?

Dr. FURNAS. That is correct.

Mr. BROOKS. But the university obligates itself to provide scientific assistance which is needed to perform a project?

Dr. FURNAS. That is correct, and they usually will name the principal investigator they anticipate will be used.

Mr. BROOKS. NACA puts up the money?

Dr. FURNAS. That is right.

Mr. BROOKS. What sort of supervision, if any, does the NACA maintain over its project?

Dr. FURNAS. If the project goes along as it should, there is little supervision. There are reports that are required, of course. Usually there is a certain amount of personal contact, but there is only light supervision.

If they have confidence in the institution, then supervision is not really necessary.

Mr. BROOKS. There is nothing in the supervision at any time that would stultify the efforts of the scientists?

Dr. FURNAS. I have not observed any cases.

Mr. BROOKS. There is no part in NACA in any kind of supervision of contract to regiment scientists, is there?

Dr. FURNAS. I have never seen that in any NACA contract, sir.

Mr. BROOKS. Have you seen too much evidence there of a military concept, or military regulations or principles being visited on the colleges or the laboratories?

Dr. FURNAS. No, sir; I never observed any.

Mr. BROOKS. So your experience has been very satisfactory with it?

Dr. FURNAS. That is correct. Except I might add, sir, in general, they have not been willing to pay enough overhead to pay the full cost.

Mr. BROOKS. Well, I think you are a true American with that approach.

Do you think that that organization is named correctly? At the time I thought that the Advisory Committee for Aeronautics was not a very good name.

Dr. FURNAS. It is actually a misnomer. Of course, it arose as an advisory committee. That was the original concept, but then we very soon had to get into laboratory work so it became a very large operating organization in the research field.

So that the name of advisory committee is obsolete. But, then, it has the aura of age on it and it is well accepted. So I never felt it was necessary to change it just for that purpose.

Mr. BROOKS. Even though we would in this program add additional powers or functions to the NACA, you would not advise a change in the name?

Dr. FURNAS. Well, the NACA would disappear. It would be the National Aeronautics and Space Agency. I think that would be an appropriate title.

Mr. BROOKS. I want to ask you this:

In the new agency that is contemplated in this bill, H. R. 11946, this provides for a board of 17 individuals and only 1 representative of that 17 would be required to be from the military. The questions I am going to ask you are not technical, sir.

Your failure to have read the bill would make very little difference there. It is just general policy I want to get to.

Do you think that is ample representation for the military?

Dr. FURNAS. Before I could express a firm opinion, I would certainly need to study the bill.

Offhand I would say only 1 out of 17 from the Military Establishment would not be sufficient, but this is merely an off-the-cuff opinion.

Mr. BROOKS. My thought for sometime has been that in the initial establishment anyway, in the changeover, that there should be a minimum larger than one from the military if we are going to have a continuation program.

If, in this time, it is advisable to have only one from the military, then that should be posponed until a little later date.

Dr. FURNAS. I tend to agree with you, but this is not a well considered opinion because I have not had the time to study it.

Mr. BROOKS. You feel we should have a civilian agency, I am sure of that?

Dr. FURNAS. Yes.

Mr. BROOKS. I am sure we all are agreed on that. We are here and we are not going to get another chance perhaps to hear from you for a long time on this subject.

Are there any recommendations other than what you have made in your general statement that you would like to give this committee, which would assist us in pushing further and faster the program that we have under study here today?

Dr. FURNAS. I do not believe so, sir.

Mr. BROOKS (presiding). Thank you.

Mr. Hays?

Mr. HAYS. I have no questions.

Mr. BROOKS. Mr. Metcalf.

Mr. METCALF. Thank you, Mr. Chairman.

Dr. Furnas, when you were discussing with the chairman of the committee the need for power in the year 2000, you omitted falling water. That is a matter of a great deal of interest to the area from which I come.

Was it your idea that nuclear power would replace falling water, or that we would need all the power?

Dr. FURNAS. You will need the falling water and other things, too. Falling water, hydroelectric power, now supplies only about 1 percent of the total energy used in the United States.

If we developed all of it, it would still only supply a few percent, even at the present time. In 50 years it will just be a very small proportion, but we will continue to use falling water because it is convenient, should I say, and also the matter of dammed-up water is of importance in flood control, it therefore has at least a dual purpose.

So it is going to continue to be used. Where it is available close by it is inexpensive and it will probably continue to be so. So we will use it, but it will never solve the nuclear energy problem.

Nuclear energy will not replace it, but will be supplemental to it.

I should like to point out also that the use of electrical energy in the United States doubles in every 10 years. So if you carry that on for 50 years we have every reason to believe that the trend will continue, we will need 32 times as much power in 50 years as we have now, and we are going to have to use every available source of energy.

That is the reason nuclear energy is so important.

Mr. METCALF. I was sure that that is what you meant. In connection with other hearings in other committees we have had many educators before us who are talking about Federal aid to education.

The other day, the United States Chamber of Commerce said there were more than 81 different Federal-aid-to-education programs going.

That elicited a response from some of the educators that many of these were not Federal aid to education, but education's aid to the Federal Government.

I was interested that you had stated there was not enough overhead on such contracts.

Dr. FURNAS. That is right.

Mr. METCALF. Testimony has developed that many of these colleges are helping the Federal Government by carrying some or all of the overhead and thus paying some of the expenses of research out of their own funds.

Dr. FURNAS. That is correct. This might be repetitious—if you would not mind I would like to read, if I can find it, a portion of testimony I gave before one of the subcommittees of the House Government Operations Committee last year on this matter of overhead. This was in answer to a question.

Incidentally, this was a hearing on January 29, 1958, before a Subcommittee of the House Committee on Government Operations. Item 10, which was posed essentially as a question or for discussion:

> Any suggestions regarding actions Congress or the executive agencies can take to facilitate and stimulate scientific research and development in the United States and in the free world or to remove impediments thereto.

I said:

> Finally, I would like to speak of the support of university activities. As you well know, nearly all universities are in serious financial straits. It is also generally true that the more research a university does, the more serious its fiscal difficulties.
>
> In large measure this is due to the fact that, in practically no instances, do any of the Government agencies pay the full, that is, direct plus indirect costs, of research which is undertaken on Government grants or contracts.
>
> The losses on many projects, especially those supported by certain agencies of the Government, are often very severe. The more prosperous a university is in such research, the greater the loss.
>
> The inevitable result is that faculty salaries for both teaching and research have to be left at an unrealistically low level. To put it mildly, this has certain deleterious effects Because of low salaries, faculty morale tends to shrink to a low level. This is almost universal at the present time.
>
> Second, the better research men keep receiving tempting offers of higher salaries from Government agencies and from industry. Many of them accept such offers. This leads to a continual leeching away of the best talent and the weakening of the research accomplishments in the universities, which are the most important source of basic research, as well as of scientifically trained manpower. This definitely is not in the public interest and the situation should be remedied.
>
> I can illustrate the situation best by citing the current experience of the institution which I know best, and which I now head, the University of Buffalo. For the fiscal year 1957, the indirect costs—overhead—associated with research as established by our firm of public accountants in accordance with accepted accounting practice, was 81.17 percent of direct salaries.
>
> During the fiscal year 1957, this university carried on \$1,945,503 worth of research on contracts and grants. The direct salaries involved were \$1,046,505. Accordingly with the above-established percentage, we should have received \$859,913 for indirect costs. Actually, the total amount we did receive to cover these costs was only \$255,838.
>
> Thus the loss on research operations at my institution for this 1 year was \$604,075. Had this latter sum been made available, it would have been used largely for establishing more equitable salaries and would thus have greatly improved our research performance and potential. The total operating cost of my institution for both instructional and research work during this same fiscal year was \$6,114,055 Thus the amount of loss on the research contracts was 9.9

percent of the total budget. Such a percentage loss can well make the difference between making or breaking an institution, or between low and high performance.

In this instance, 34.8 percent of the research losses were from Federal Government contracts or grants. It is almost certain, because of the various national trends, that an increasing percentage of the research support in my own institution, will in the future, be coming from the Federal Government. So, the situation will become worse instead of better, unless remedial action is taken.

Mr. METCALF. If that condition continues it will mean that the that the college will have to discontinue this research service to the Federal Government?

Dr. FURNAS. It will certainly cut it down.

Mr. FORD. Will you yield?

Mr. METCALF. Certainly.

Mr. FORD. In the contract for research and development which the Department of Defense or the individual services make with universities or colleges and with private research organizations, do the private research organizations do any better in that regard than the universities or colleges do?

Dr. FURNAS. This depends on whether the private research organization can operate on the business-type contract, or whether they have to operate on the university-type of contract, however the organization is set up.

The military organization, particularly the Navy, which I think is better to negotiate with than the others, usually allow the bluebook formula, which is very much better than some of the other Government agencies, but I still think it does not adequately cover all of them.

In the case of my own institution the bluebook formula gives us an overhead of 65 percent plus.

Our public accountants say the overhead should be 82 percent.

In my own case the situation, which is worse, is that the National Institutes of Health by law is restricted at the present time to 15 percent of overhead which is completely inadequate.

This is my own situation. I do think the bluebook formula should be revised so that it gives more adequate consideration to the overhead for universities. All of the Government agencies should certainly go at least as far as the bluebook formula.

Mr. FORD. Who uses the bluebook?

Dr. FURNAS. The three military establishments.

Mr. FORD. Then the military seems to do better in this regard than other Government agencies.

Dr. FURNAS. That is correct, sir.

Mr. FORD. Is the bluebook formula acceptable to colleges and universities, or not?

Dr. FURNAS. In my case I feel it is not adequate.

Mr. FORD. Is the bluebook formula used with private research organizations?

Dr. FURNAS. If they are part of the university, yes. For instance, there are research foundations which are an integral part of the university and the bluebook formula is applied there.

Mr. FORD. It does not seem to me that it is fair that private research organizations should do any better than colleges or universities, but how do we get at that problem?

Dr. FURNAS. Pay all of them adequate overhead, sir.

Mr. FORD. When we make the money available we do not specify except in the HEW case, and that is by law.

Is it just a heritage which causes the problem or what is it?

Dr. FURNAS. I must say that I am not clear as to what can be done by legislation on this and how much of it is heritage.

I must also say that I think the universities themselves are at fault to a large degree because they have been willing to accept work at less than it cost them.

But you will never be able to get universities to have a unified front so I am afraid we are going to have to live with that.

Mr. FORD. Thank you very much.

Mr. METCALF. I thank the gentleman from Michigan for points which are of extreme interest to us.

Dr. Furnas, when you examine this legislation I hope you will be sure that this new agency we create does have the power under the law to adequately compensate the universities for these various very important research programs that have contributed so much not only to national defense, but to the entire domestic economy.

If you are not sure that there is adequate law to protect the universities, I hope you will suggest some language that will take care of that situation because time after time this question has been raised in recent months.

I believe it is one of the grave obstacles confronting us in developing future research and using our colleges and scientists for the betterment of our country.

Dr. FURNAS. I could not agree with you more, sir.

Mr. METCALF. Thank you.

Now, I think you developed rather completely the justification for the expense that this space program is going to cost. You showed and demonstrated by many instances that the result would be worth the expense.

You talk about another phase, how it was going to be organized. In your discussion with Mr. Brooks and with the chairman you used such language such as you felt the NACA had done very well and probably that was a good solution.

But "very well" is not enough. We want the best solution to achieve these results that you point out. I hope when you go over this legislation you will think not whether a 17-man board will do very well or a director will do very well, but whether that is the best kind of organization.

When you respond to the chairman's question, you will answer with that point in view?

Dr. FURNAS. Yes, sir.

Mr. METCALF. Thank you, Doctor.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Doctor, several months ago one of the Members of Congress called upon a group of scientists to give their reasons as to just what was wrong with our missile and space research program. These gentlemen made certain observations, one of which was that at the present time science should have a place in the Cabinet and that it was important that this action take place as soon as possible.

How do you feel about that, Doctor?

Dr. FURNAS. My own opinion is that we should not have a cabinet post, a secretary of science, I think, would not serve any good purpose. I think it would add to the confusion.

Mr. NATCHER. Another observation that these gentlemen made was to the effect that a great portion of our material should be de-

classified. They felt that that would help us with our present research program. How do you feel about that?

Dr. FURNAS. I think there is a great deal of material which should be declassified. This can never be clean-cut. A good part of the reason for the lack of declassification is simply the great mass of material. Those who are responsible for the declassification are ordinarily not particularly interested and often are not in a position to spend the time and the effort to go through the great masses of material to see what should be declassified.

My own tendency is to be on the liberal side of declassifying, or not classifying in the first place, because every time you classify something you do hold up progress.

The question is: Are you declassifying ourselves or the possible enemy more?

We tend to overclassify and keep too many things classified. It is like legislating virtue. I do not know how you do it.

Mr. NATCHER. This group also made the suggestion, Doctor, that we should pool our scientific knowledge and skill with our allies today considerably more than we are doing. How do you feel about that?

Dr. FURNAS. Yes, sir; I believe that is correct. Western Europe is a great source of information and talent which I do not think we are adequately utilizing. This has its great difficulties, but I think we should pursue it more assiduously than we have thus far.

Mr. NATCHER. Doctor, I understand that you have not had a chance to read the bill. But there is one question I would like to ask you concerning the observations made by this group of scientists.

This bill, Doctor, provides that the Space Board should be composed of not exceeding 17 members. No more than 8 of the members of the Board are to be designated from appropriate departments or agencies of the Government, including at least 1 from the Department of Defense.

Members of the Board other than those appointed under the above section shall be eminent in science, engineering, technology, education, and so on.

Now, that is the present bill we have before us for study. It incorporates the President's proposal concerning this new space agency. This group of scientists, Doctor, in their opinion, felt that this new organization should be a commission composed of from 5 to 7 members; 3 or 4 of the members should be scientists; 1 from the military, 1 from industry, and that the chairman or the director should be a scientist well equipped from the standpoint of training and ability and also should have a fine administrative background.

Now, I realize, Dr. Furnas, that you have not had a chance to go through the bill and to make observations and arrive at your own opinion as to the bill. How do you feel about the suggestion that instead of having a director and a committee here of 17, that it should be a combination as outlined by this group of scientists? How do you feel about that, Doctor?

Dr. FURNAS. In my own opinion, and I must say this is based largely on the suggestion of NACA, is that this approach of the committee is the better one.

I also want to say that I certainly concur in the requirement for the director, that he be a scientist with high standing and administrative ability.

The reason I say a committee rather than a commission is a commission is necessarily going to be closely involved in the operating and probably the real reason for having a commission is when there are regulatory functions involved.

This is in the case of the AEC, there is a reason for having a commission there because there is a large body of regulatory element involved there, for safety and other things.

I do not believe there is the implication of this necessity for regulations in the space agency that is being discussed as there is in the case of the AEC.

Hence, I do not believe there is really as much of a justification for a commission. I would rather see it approached from the committee point of view and, of course, if this is not satisfactory, there can be later legislation if the commission function does seem to be desirable.

I, myself, cannot visualize that regulatory function, which is the real justification for a working commission.

Mr. NATCHER. Under this bill it provides for the director who is ot be appointed by the President and confirmed by the Senate.

In your opinion this director should be a well qualified administrator?

Dr. FURNAS. Without question.

Mr. NATCHER. And should be a scientist?

Dr. FURNAS. Yes, sir.

Mr. NATCHER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Dr. Furnas, I wish you would elaborate a little bit further with reference to your answers to the question by the gentleman from Kentucky in regard to making a Cabinet post of the Department of Science. You say it would add to the confusion

Why would it add to the confusion?

Dr. FURNAS. Because I think everybody which is added, in general, tends to add to the confusion. It is true that is a generalization.

Science so permeates everything that I don't see how you can pull everything together at one point and have a superman with his staff who will have all the right answers. I think it is analogous to the fact that everyone uses English language, presumably, in all Government activity, but I don't think anyone suggests there should be a Secretary of English as a Cabinet post.

I think the Secretary of Science is a little analogous.

Mr. NATCHER. You know we have a Department of Interior which has certain jobs to do. Do you anticipate that the time may ever come when we will need a Department of Outer Space?

Dr. FURNAS. I doubt it, but I suppose my crystal ball is very cloudy on that point. I do not think we should take that trouble on at the present time.

Mr. NATCHER. Now, you do not sound very optimistic as to our conquering and making extensive use out of outer space.

Dr. FURNAS. No, sir; I don't think we will make extensive use of outer space if you are speaking in terms of the number of people that will be there. It will be very few.

Mr. NATCHER. Assuming that we had no demand from a military standpoint, that the world was totally and completely at peace, and no one else was interested in space, would we be interested in space?

Dr. FURNAS. Yes, sir.

Mr. NATCHER. Why?

Dr. FURNAS. The acquisition of knowledge.

Mr. NATCHER. You would put it strictly on the basis of acquisition of knowledge; that is the curiosity of our scientific minds?

Dr. FURNAS. That is correct, sir. quite analogous to the study of astronomy in that way.

The basic motivation has been the acquisition of knowledge for astronomy. It has proved very useful just as all knowledge has proved useful, but the real basic motivation has been the acquisition of knowledge.

Mr. NATCHER. Now, has the basic motivation been the acquisition of knowledge?

Dr. FURNAS. I am speaking of astronomy now.

Mr. NATCHER. I am speaking of the achievements we have made in view of the fact that we have satellites orbiting the earth right now. What was the incentive in putting those in orbit? Was it curiosity of the scientific minds?

Dr. FURNAS. A large block, yes. This did not result in dollars, however.

Mr. NATCHER. They all go together, do they not?

Dr. FURNAS. Perhaps I did not state the point specifically enough, but the real justification for the effect and the money which is going to be put on exploration of space is first our military defense. We are not sure to what extent it will be useful, but we know it will be useful to a certain extent.

This is No. 1.

The second point is the knowledge which is gained will be useful to the human race. These are two motivating factors which are powerful and justify the expenditure of money in the eyes of the voters. This we have always to keep in mind, but in the basic motivation of the research scientists, to him it is always sufficient justification to go after something just in order to add to our fund of knowledge.

This is what distinguishes a fundamental research scientist. So there are three very important factors, but only on the first two can you get very much money. These are the practical aspects.

Mr. NATCHER. I certainly appreciate it. I think what we are faced with, Doctor, at the present time, is a political matter, and I am not speaking of the narrow partisan thing, but the overall situation. We are faced with being pretty realistic in this thing and I think that is the whole point of our being here this morning and discussing the possibility of a new agency.

That leads to the next question:

Do you feel we need a new agency, Doctor?

Dr. FURNAS. Yes, sir.

Mr. NATCHER. Why?

Dr. FURNAS. Because as it is now it is a matter of bits and pieces. Each of the individual services wants to set up its own space agency and I certainly agree that this should be a civilian agency.

I think it should be one that does not exist except insofar as it makes a very logical step to expand the function of NACA to do these things. NACA has been nibbling on the edge of this and it is the logical one to take this over.

Mr. NATCHER. What do you anticipate will happen to ARPA?

Dr. FURNAS. This is one of the things that puzzles me a little bit. I don't think any answer can be guessed at on that until we see what happens to the Department of Defense reorganization.

Mr. NATCHER. In other words, before we can, in my opinion, intelligently write a bill here and set up a new agency, I think we are going to have to determine whether or not ARPA shall be permitted to continue to exist or not.

How can we set up a new agency if that is going to be a confused point at issue?

Dr. FURNAS. I believe it should be the other way around. I believe the new agency should be set up and then the ARPA function adjusted within whatever happens in the Department of Defense to be adequately coordinated with the new agency, the NASA.

Mr. NATCHER. Would you anticipate authority in the new agency would be in a position to determine what happened to ARPA?

Mr. FURNAS. Not authority in the strict sense of the word, but I anticipate a well coordinate program. I do not think you can solve those problems of coordination and management by legislation. You can only provide the framework in which the direction is worked out properly.

Mr. NATCHER. Of course, that still goes back to the heart of the issue, it seems to me. You have made a very fine defense of NACA and I am not going to necessarily disagree with you.

Of course, I know there are people who disagree with you, but merely upgrading and changing the name of NACA is not going to accomplish the purpose, is it, Doctor?

Dr. FURNAS. If they are assigned the prime responsibility for the research in this area which we are calling exploration of outer space, yes.

Mr. NATCHER. All right. In what way is NACA limited by legislation or otherwise, today, in its authority and responsibility to move into this field? Are they restricted in any way in the field?

Dr. FURNAS. I think their assignment is the science of aeronautics. It does not include astronautics at the present time.

Mr. NATCHER. In other words, they have been bootlegging a little bit in getting in on some of these programs; is that not true, toying with something which you would say they did not have authority to get into?

Dr. FURNAS. I would express it, sir, that the fields have merged.

Mr. NATCHER. That is the point that the gentleman from New York has from time to time brought up, in other words, the degree or where the borderline comes between outer space or space as compared to what you might call aeronautics.

What is the scientific definition, Doctor, of the difference between aeronautics and astronautics? I think I know in general terms what Webster says about it. Aeronautics implies there is some air there.

In other words, aeronautics, strictly speaking, is confined to airborne vehicles and the physics of the atmosphere itself.

Astronautics is essentially those vehicles and devices which are out beyond where there is any perceptible atmosphere at all.

I might add that a ballistic missile, however, despite the fact that it does go through the atmosphere when it goes up and comes back through the atmosphere when it comes down is really an astronautical vehicle because it is following a ballistic course rather than something that is airborne.

The CHAIRMAN. In other words, it is difficult to bring about a straight line of divisibility.

Dr. FURNAS. Yes, sir; this is the reason I say the fields merge.

Mr. SISK. In view of the merger, that, of course, was my reason for asking you about any limitation on NACA. You say they have done an excellent job. I will not argue with you about that.

Let me ask you this: If their powers were broadened to include space or astronautics, do you think that would solve the situation and that we need no further agency or step at the present time?

Dr. FURNAS. Remember, sir, we are not creating a new agency; we are enlarging the assignment and responsibility and I think probably some of the authority of the NACA.

Mr. SISK. Now, I think we are getting down to the point. Is that what we are doing? That is not my opinion of what we are doing by any means.

Dr. FURNAS. Then I think I will have to study the bill first, sir, before I express an opinion.

Mr. SISK. Maybe that is what the authors of the bill had in mind. I do not know. Certainly it is not what I anticipate we had in mind.

But I feel that is what you feel is needed; is that right?

Mr. FURNAS. An expansion of the function and certainly the authority to a certain degree with the responsibility.

Mr. SISK. Doctor, to what extent do you feel we are utilizing at the present time our scientific and engineering know-how in this country?

Mr. FURNAS. Are you speaking of the efficiency with which we are utilizing them?

Mr. SISK. Yes. You know, of course, Doctor, of the great debate to some extent that is going on and has gone on for some time that we are falling behind in engineering know-how and engineering application and so forth, and that Russia is making great strides in this field, some of which I do not necessarily agree with, but I am concerned as to whether or not we are properly utilizing our scientific knowledge in making proper application of it.

I was curious as to whether you had any opinion about that, Doctor?

Dr. FURNAS. We are not nearly as inefficient as the severer critics indicate. However, we are a long way from perfection, I feel.

The real crying need is for a larger number of really top-flight scientists and engineers. We have a large number of mediocre, such as there are, of course, in any profession. The thing which is rather discouraging is the fact that we have not at the present time the prospect of having enough top-flight scientists and engineers 10, or 20 years from now.

Mr. SISK. Where do you think we stand with reference to Russia in that field, top-flight scientists?

Dr. FURNAS. I have no way of really knowing or judging the proportion of topflight ones that they have as compared to us. We do know they have some good ones. We do know they are producing more than we are at the present time.

Mr. SISK. More topflight people?

Dr. FURNAS. I have no way of grading them.

Mr. MCDONOUGH. Will the gentleman yield at that point?

Mr. SISK. I will be glad to yield.

Mr. McDonough. If we had more topflight engineers, physicists, and scientists today than we have, what more could we do than we are now doing? I am talking of astronautics and use of outer space.

Dr. Furnas. I think we would progress more rapidly. We would progress more rapidly at less cost.

Mr. McDonough. General Daley was here yesterday and I asked him if he was moving as fast as he could in the ballistic missile field. He said he could not go any faster than he is going right now.

Now, the question of topflight scientists and physicists in the exploration of outer space and the question related to it is whether we have as many such people as Russia. It has always posed the question in my mind whether we could go any faster if we had these people.

Dr. Furnas. You do not necessarily go any faster by putting more engineers on the design board.

Mr. McDonough. Then Russia cannot move any faster than we are because they have more scientists if that is true.

Dr. Furnas. If you have really intelligent and very competent scientists and topflight engineers in the initial planning stage, you make fewer mistakes. In all of these experimental things you have more mistakes than you have successes.

So your speed depends very greatly on your ratio of right theory or rightness, if you want to call it that, as against the number of mistakes.

So the more really topflight, very intelligent, and very capable people you have, the fewer mistakes you make and the more rapid your progress.

Mr. McDonough. That stimulates another question in my mind.

Do you think at the present time Russia has advanced scientific knowledge on astronautics that we do not have?

Dr. Furnas. I doubt, sir, if they have knowledge that we do not have. They might have, but I don't have reason to believe they do.

Mr. McDonough. They are operating under the same basic research and attempting to implement the natural laws the same as we are, so far as astronautics are concerned?

Dr. Furnas. Yes, sir; the law of physics are the same in Russia as they are here.

Mr. Sisk. I have one concluding question, Doctor, and then I will yield the floor.

What amount of urgency, then, do you place on this program? Do you feel we have become unduly alarmed with reference to trying to expedite our conquest of space and our utilization of it?

Dr. Furnas. No, sir; I do not think we have become unduly alarmed because this is a race from the military and national defense point of view and there is nothing more difficult than to catch up in a race after you have slipped behind a little bit.

It is certainly very important that we proceed as expeditiously as possible, but avoid being frantic. If you become frantic, you soon wear yourselves out and you make less progress, but I think we should take this very seriously and expedite it with all dispatch.

Mr. Sisk. It is not actually true when you analyze it that the vehicles, the hardware that has been developed, the actual research and so forth that has put us at least in a limited way into space and that we have been able to launch satellites, are strictly programs developed by the military and that no civilian agency in a sense has contributed a great deal, NACA or anyone else?

Now, I think that should have some consideration in the type of agency we might set up to expedite the program.

Dr. FURNAS. I think it is not correct to say that other agencies have not contributed.

Mr. SISK. I did not mean to say they had contributed nothing, but I am speaking of the great majority of contributions.

Dr. FURNAS. As far as the bulk of the hardware, yes; it has been the military, namely the rockets and control systems.

The National Science Foundation in the International Geophysical Year, has been very significant. Also the volunteer people you might say in the national committee headed by Dr. Kaplan, for the International Geophysical Year have contributed a great deal to the scientific theory, to the instrumentation, and are contributing tremendously to the interpretation of results.

So that I think their contribution has been very significant and will continue to be so.

As far as the tons of hardware, which is primarily the propulsion system, this has been the military, that is correct.

Mr. SISK. That is all, Mr. Chairman.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Doctor, you mentioned the new sources of potential power in outer space. If there are quantities of oxygen that could be used to propel a vehicle in outer space, how are we going to collect it and use it practically?

Dr. FURNAS. Sir, you will have to go up there to use it.

Mr. McDONOUGH. Yes, of course.

Dr. FURNAS. This is a layer which is roughly 60 miles above the surface of the earth.

Mr. McDONOUGH. Nascent oxygen; is that close?

Dr. FURNAS. That is right. Apparently this is one of the things we don't know. Apparently 50 percent of the oxygen molecules are in that condition.

Perhaps it will be useful to have a vehicle circumnavigating 60 miles above the earth for a reconnaissance vehicle.

If it does work out, they will have a perpetual energy supply there. I don't know if it will be useful for civilian travel, but the thing that intrigues me most is the fact that we can study that material there and learn how to use it, and it is going to help us to learn more about the use of some free radicals.

Oxygen is not the only thing that can be treated this way. We are going along with the Bureau of Standards on research on free radicals at this time. I think the knowledge we can get 60 miles up will be useful.

Perhaps that layer of fuel up there will be useful to military or civilians. I don't know.

We do need to find out.

Mr. McDONOUGH. In other words, to get to that position, you would use another type of fuel and after you get there you would have to have an engine designed to use the free oxygen in the air.

Dr. FURNAS. Yes.

Mr. McDONOUGH. Would that be an explosive propelling force?

Dr. FURNAS. No, it would be a ram jet with continuous thrust. You would squeeze the molecules together and just by the fact that

you bring them close together they would recombine and produce energy.

You may have heard of the atomic hydrogen welding torch which was developed years ago by the General Electric Co. in which they take hydrogen and pass it through an electric arc and break up the hydrogen molecules into the two atoms.

When they recombine with oxygen they produce hotter flame than the hydrogen-oxygen flame.

What we are talking about is quite the same reaction.

Mr. McDonough. That would remove the danger of radiation in a nuclear powered ship, would it not?

Dr. Furnas. Yes, sir.

I might point out that the source of energy in this case is solar energy, the energy from the sun's rays.

Mr. McDonough. Do we know that there is a consistent quantity of that at a 60-mile height?

Dr. Furnas. This I am sure is one of the gaps in the data. Perhaps Dr DuBridge will know more on that than I do.

Samplings from the rockets that have gone up have indicated that there is a consistent layer there. I think that some of the future satellites that we send up may get some more information on that, although it will be too close to the earth for the satellite orbit.

As they go up and as they come down we may be able to get some more information on this.

Mr. McDonough. The energy source will be the combination of molecules; is that right?

Dr. Furnas. That is right.

Mr. McDonough. That is the heat of association?

Mr. Furnas. That is correct.

Mr. McDonough. As distinguished from the heat of disassociation in the nuclear bomb; is there such a thing?

Dr. Furnas. You could hardly speak of it as disassociation in a bomb. That is a different reaction.

Mr. McDonough. What do you think of establishing an extensive course of astronautics at the Air Academy at Colorado Springs?

Dr. Furnas. You mean as part of the undergraduate work?

Mr. McDonough. Yes.

Dr. Furnas. I presume this will be one of the things which will be forthcoming. It is a natural course of events if we are going to use astronautical vehicles.

Mr. McDonough. You mean that there is a correlation between aerodynamic and astronautics that should be associated with the study of these things?

Dr. Furnas. Particularly in the matter of training at the undergraduate level; yes, sir.

Mr. McDonough. We always have a problem, such as we attempted the other day, on the reentry of a cone shot in outer space and coming back to earth. Why is there not the same problem of the cone entering outer space with the power behind it as there is in reentering space?

Dr. Furnas. Because you go slowly as you go up.

Mr. McDonough. You mean you come back faster?

Dr. Furnas. Yes, very much faster.

The Chairman. Mr. Fulton.

Mr. FULTON. Glad to have you here, Dr. Furnas.

Dr. FURNAS. Thank you.

Mr. FULTON. I was interested in your discussion with the gentleman from California on the ionization of oxygen. Has that layer ever caught fire due to any of these rockets?

I think I read some place where some had caught fire a little bit; is that right?

Dr. FURNAS. I only know of one experiment, and I have forgotten just what was ejected, but they did eject, I guess it was sodium at very high velocity at that altitude and this really served as a catalyst for this recombination of the oxygen molecules and there was, shall I say, a quite brilliant light in the area which gave evidence of the recombination if you had the proper material up there.

Mr. FULTON. So if somebody wanted to destroy the world, they could put the proper catalyst up there and this whole circle of oxygen would be ionized and combined?

Dr. FURNAS. The effect would be quite limited. It is not something you can trigger and have the world entirely circled with fire. I do not think we need to feel uncomfortable on that.

Mr. FULTON. With respect to the ionization we are speaking of, their breaking O_2 down to 2O, could that be used in conjunction with ordinary ion propulsion that he speaks of?

Dr. FURNAS. I personally do not see offhand how we could. But I am not sufficiently experienced in that field to give a definite answer to that.

Mr. FULTON. So the use of this ionized oxygen would really be limited to this band above 60 miles above the earth?

Dr. FURNAS. Yes.

Mr. FULTON. And the space vehicle or the engine would have to really be confined to that area in case we were going to have the propellent taken from the atmosphere.

Dr. FURNAS. That is correct, sir.

Mr. FULTON. Have there been any experiments on the ionizing of oxygen for some vehicles regardless of this particular layer that we are speaking of?

Dr. FURNAS. Roughly analagous, this is the free radical research I spoke of.

Of course, many substances that you can break up in the ionized forms, tend to, of course, at the ordinary pressures and temperatures, recombine very rapidly. I spoke of the hydrogen torch which is used. They recombine in a matter of a few thousandths of a second.

However, when you take them down to a very low temperature, you can keep them in this free radical form. This is essentially the approach that is being made now to see whether or not you can store up greater concentrations of energy by taking a substance, which is ordinarily a fuel anyway, and then giving it this extra storage of of energy by dividing it into ionized form and holding it that way until you want to recombine again.

We do not know this will work, but there is the possibility. We are quite sure that it can work as far as the laws of chemistry are concerned, but whether or not you can have a practical device that can handle it, we do not know.

It is very touchy material because when it does start to recombine it does so with great violence.

Mr. FULTON. The point I was making is, would it be worthwhile to have a program of research on this in order to reduce the size, the bulk as well as the weight, for example, of the Vanguard in the first and second stages?

Dr. FURNAS. There is a program of research on this sort of thing. I think it should be increased and emphasized more.

Mr. FULTON. How much more money do you think should be spent on such a program?

Dr. FURNAS. I would have to go into a detailed study of the program.

Mr. FULTON. You can place that in the record.

Another point I would like to make is this: You have spoken of the fact that we should not probably look at outer space in the context of freedom of the seas; is that right?

Dr. FURNAS. I said that I did not feel that the outer space was not an analogous case to the freedom of the seas.

Mr. FULTON. On what basis should the United States set its policy? Should we have a national space policy as distinguished from a United Nations policy?

Dr. FURNAS. I am afraid you are getting beyond my depth or my reach; I am not sure which.

Mr. FULTON. You would favor a national space policy for the United States, would you not?

Dr. FURNAS. If you can set up a practical policy, yes, but I am puzzled as to what would be involved in this policy.

Mr. FULTON. Would you try to get an international conference? I have suggested that several times, a meeting of all the nations to try to set up some sort of agreement or treaty that would control outer space and its development.

Dr. FURNAS. I must say, sir, at the present time I do not see how we can physically control outer space. So I think any such treaty would be meaningless.

Mr. FULTON. Grotius had the idea of freedom of the seas and then John Selden of England came up in 1655 with the dominion of the seas.

Do you think the United States should try for dominion of outer space as distinguished from leaving it as a free space and we do what we wanted?

Dr. FURNAS. I think for the moment we should leave it as free space to do what we wanted, because I do not think we have enough wisdom to devise a policy which will mean anything.

Mr. FULTON. So you would not go into outer space as a United States policy, but primarily as a military or dominion procedure?

Dr. FURNAS. I think our primary reason for going into outer space at the present time is military; yes.

Mr. FULTON. Should we race with Russia for the control of outer space, then?

Dr. FURNAS. I think it is highly important that we get vehicles there which will be useful for military reconnaissance. This is the outstanding aspect.

Mr. FULTON. So that you feel it is necessary to have a national space exploration policy for our own security?

Dr. FURNAS. That is correct, sir.

Mr. FULTON. May I finish with this. I believe that you had some contact with the decoding of the signals of the sputnik, did you not?

Dr. FURNAS. No direct contact; no.

Mr. FULTON. Do you, of your own knowledge, know what the results of these decoding operations have been if it is not classified material?

The CHAIRMAN. I might say that any question asked that goes into classified areas, you gentleman just simply say so.

Dr. FURNAS. All that I have learned on this has been with conversation with others that have been more involved in this and they say they have gotten so far very little information from the Russian signals, from their instrumentation. Apparently the Russians have published a little bit, but not very much. They have promised to publish more.

The information so far gathered from the Russians has been fragmentary.

Mr. FULTON. Thank you very much.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. Dr. Furnas, do you look upon the control of so-called outer space as well nigh an impossibility?

Dr. FURNAS. Yes, sir.

Mr. KEATING. Because of the vastness of the area?

Dr. FURNAS. That is correct.

Mr. KEATING. Do you look upon outer space as different in kind from the atmosphere immediately above the earth or just an extension of the atmosphere.

Dr. FURNAS. It is different in kind in the sense there is no atmosphere there, but primarily because of the vastness of space.

Mr. KEATING. It also has entirely different physical properties?

Dr. FURNAS. That is correct.

Mr. KEATING. There are differing views. We have had a good many Defense Department witnesses and some have said that the difference between the earth's atmosphere and outer space was like the sea with different areas of density.

Others have felt that there was a more vital difference, as I would put it, the difference between land and sea.

Which do you think is more accurate, or is it in between?

Dr. FURNAS. I would vote for the more vital difference, sir.

Mr. KEATING. That was my impression.

In your answer to the gentleman from California that there should be a course of astronautics in the Air Academy, you did not mean to exclude West Point and Annapolis in that?

Dr. FURNAS. No, sir.

Mr. KEATING. In other words, this is a matter that undoubtedly engages the attention of the young men in all of our service academies?

Dr. FURNAS. I think so; yes, sir.

Mr. KEATING. And the University of Buffalo?

Dr. FURNAS. Yes, sir.

Mr. KEATING. Now, you are of the school of thought, I believe, and we have conflicting testimony on this, you are of the school of thought that this new Agency should not be limited simply to research.

Dr. FURNAS. Here, sir, you get into the definition of research. I think the scope should be research and whatever is necessary in order to prove the feasibility of vehicles or devices.

In other words, I do not think it should be confined purely to fundamental research. I think the pattern which the NACA has worked

out, of the degree of development they have gone through, has been quite satisfactory for their aeronautical field.

Mr. KEATING. The functions of the agency include the development, testing, launching, operation of aeronautical and space vehicles. In another area they are given the authority to acquire, construct, improve, repair, operate and maintain laboratories, research and testing sites and facilities, manned and unmanned aeronautical and space vehicles, and so forth?

Dr. FURNAS. Yes.

Mr. KEATING. Now, this is a very broad operational authority, would you not say, sir?

Dr. FURNAS. Yes, but it is necessary to carry on this research in space. You are simply hobbling horses if you are saying you can only take steps so large. The distinctive point is that they shall not go into the manufacture. In other words, they shall not do production and development, but it is only for their exploration activities they need to develop the vehicles that have not been developed before.

Mr. KEATING. Yes, I understand your point. You think they should have authority?

Dr. FURNAS. They should; yes, sir.

The CHAIRMAN. Of course you recognize that the bill calls for not less than one member of the Defense Department, it could be more. Of course that is a matter of the discretion of the President. He could appoint more than one member.

Dr. FURNAS. Yes, sir; but I do believe one is too small a minimum to be specified.

The CHAIRMAN. You do have sufficient confidence in the President of the United States to know that he would use his judgment.

Dr. FURNAS. The present President, yes, sir.

The CHAIRMAN. Well, I said the President of the United States.

Mr. KEATING He thought, though, Mr. Chairman, that the minimum that we put in the legislation should be something above one.

The CHAIRMAN. I am not expressing any views, I am just exploring.

Mr. KEATING. I was not sure that you got his thinking.

The CHAIRMAN. I think it is well to explore with the witness to get their views.

My mind is completely open. I have some fixed views but I will discuss them in executive session.

Mr. Ford?

Mr. FORD. Dr. Furnas, from your experience as Assistant Secretary of Defense for Research and Development, do you think it is wise or unwise in the appointment of individuals from the Department of Defense that there should be one from each service?

Dr. FURNAS. With the present setup of the Department of Defense yes, sir, because this is the only way you can get appropriate representation of the different military disciplines if you choose. Whether this will be wise after the legislation on the reorganization of the Department of Defense I could not express any opinion.

It depends on how that turns out. I think it is essential that there is representation of the major activities, and if those major activities are separate and autonomous, you have to have those representatives there.

Mr. FORD. I am not entirely familiar with the details of the proposed change in the research and development aspects of the Depart-

ment of Defense but I gather from what I have read that it would give a greater degree of control in the Assistant Secretary's Office, more, for example, that what you had when you had their responsibility?

Dr. FURNAS. Yes, sir.

Mr. FORD. As a sideline to this legislation do you concur in that new approach to that problem?

Dr. FURNAS. Yes, sir.

Mr. FORD. It would have made your job much easier and more effective?

Dr. FURNAS. I do not know it would have made it easier, it would have made it more effective.

Mr. FORD. If that proposal goes through, that aspect of the reorganization, then you would see less necessity for equal representation from each of the three military services in this legislation?

Dr. FURNAS. That is correct.

Mr. FORD. As I look at section 6 (b) (5), the pertinent portion is on page 8, it seems to me that the legislation, as drafted now, would seem to take care of the problem raised by the gentleman from Montana, Mr. Metcalf. I would like to read it and see if you concur.

It says,

> In performance of the above functions the Agency is authorized without regard to section 3648 of the Revised Statutes, as amended, to enter into and perform such contracts, leases, cooperative agreements, or other transactions as may be necessary in the conduct of its work and on such terms as it may deem appropriate, with any agency or instrumentality of the United States, or with any State, Territory, or possession, or with any political subdivision thereof, or with any person, firm, association, corporation, or educational institution.

That would seem to give a very wide discretion, a high degree of flexibility in entering into contracts and so forth.

Dr. FURNAS. My first reaction is that this seems to be sufficiently all-inclusive. I would really want to study it a little bit more before expressing a firm opinion.

Mr. FORD. It would seem to put vast authority in the hands of the Director in reality for the entering into such agreements. So here it seems to be the good will of the Director in making the kind of contract with educational institutions that would be satisfactory to them under the appropriate criteria to be developed.

Dr. FURNAS. That is true. Of course, the other factor that enters into this is the Bureau of the Budget which overrides many things in contractual regulations.

Mr. FORD. I gather then that you feel from your own practical experience that even legislation of this sort, if it is not buttressed a bit, could be hamstrung by administrative interpretations by the Bureau of the Budget?

Dr. FURNAS. That is correct. I am not sure how far legislation can go in the matter of compensation, of full compensation for work done.

Certainly speaking from the background of lack of knowledge as to what can be effective legislation, it seems to me there could be language that would make it imperative that full recognition be given to full cost in these contractual regulations. I am reading this because there are regulations now in the National Institutes of Health which prevents paying full cost. So I presume it would be necessary to require legislation that would require full cost.

Mr. FORD. In your contacts with various Government agencies where you are trying to negotiate research contracts do you find that those who represent those agencies do seek to give you adequate compensation but then they say, well, we have the Bureau of the Budget to contend with?

Dr. FURNAS. Not in all cases; no, sir.

Mr. FORD. In other words, even some of these agencies themselves or the people representing them are at fault in this problem?

Dr. FURNAS. The administration, yes, within the agencies themselves They tend to haggle. They look upon it that I have so many dollars and I want to get the most research I can out of them and if you are willing to take it at a loss, why this is what we are going to do.

Mr. FORD. If you don't we will get somebody else?

Dr. FURNAS. That is correct, and they often do.

Mr. FORD. I think it is a very serious problem. I think the committee ought to do what it can to be helpful. I am glad to hear that your experience indicates that the Department of Defense at least seems to be more realistic than some of the other agencies.

Dr. FURNAS. They are more realistic, yes, sir.

The CHAIRMAN. Mr. Feldman?

Mr. FELDMAN. Doctor, in response to a question from Congressman Keating regarding the NACA setup you said that the essential character of the Board and its functions should remain the same.

The Board, when you served on it, was the top ruling agency in the NACA; is that not so?

Dr. FURNAS. Yes, sir.

Mr. FELDMAN. You set the policy and the Director carried it out; is that correct?

Dr. FURNAS. That is correct, sir.

Mr. FELDMAN. And you had the right to discharge or change the Director if you so saw fit or at least make a strong recommendation that he be changed?

Dr. FURNAS. I could make a recommendation; yes, sir.

Mr. FELDMAN. In other words, the Board was the top authority in the Agency. Is that not true?

Dr. FURNAS. Yes, sir.

Mr. FELDMAN. Under the new proposal the only function of the Board is to recommend and advise. You can accept that, Doctor, because there is no provision in the law which says their recommendation has to be followed by the Director. In other words, the setup is changed so that under the new proposal the Director would be the top authority and the Board would have no power other than to recommend and the Director would not be obligated in anyway under this new proposal to accept that recommendation. That is the fact within the law. I do not think there is any dispute about that. I mean the new proposal.

Mr. KEATING. Would the gentleman yield to me?

Mr. FELDMAN. Yes; I will.

Mr. KEATING. I think probably the legal conclusion is right, but I am wondering if that does differ from the setup of the present NACA or whether what Dr. Furnas was talking about was the way it operated in practice rather than the legal way it was set up.

Dr. FURNAS. I am not familiar sir with the language of the act on NACA but I was under the impression that its role was advisory, that

it was in effect controlling because the Director did follow the consideration of the Board in determination of policy.

The CHAIRMAN. We can settle that very quickly. Here's a chart given to us by Dr. Dryden. The National Advisory Committee for Aeronautics is at the top and the NACA Headquarters, Washington, D. C., and the staff is under the 17-man Board.

So, organizationally, in the law the National Advisory Committee for Aeronautics could be and was the top operating unit. Now whether in fact it was or not is a difficult question.

Mr. KEATING. Mr. Chairman, I would anticipate that Dr. Dryden, if he were givin us a chart of this new Agency would set it up exactly the same even with the wording that we have in this bill.

The CHAIRMAN. He testified to the contrary, that he would be the top man.

Mr. FELDMAN. He not only said that but under the new setup he characterized the Advisory Board as "kibitzers."

The record is clear on that.

Mr. KEATING. My opinion is this, Mr. Chairman. I do not think you can look at a chart to determine what the present setup is. I do not know, I have not looked at the law, but I think we have to look at the law setting up the NACA and see by looking at that whether it differs from this law in that respect. Perhaps counsel has done that.

Mr. FELDMAN. I have and it does differ in that respect.

Mr. SISK. Would the gentleman yield there?

Mr. FELDMAN. Yes.

Mr. SISK. To clarify the answer to your question a moment ago, did you accept the thesis as propounded that when you were a member of NACA that it operated in the other direction—as a practical matter now—that is, that the Board controlled what the Director did, what Dr. Dryden did?

Dr. FURNAS. It seemed to me the action of the Board was essentially analogous to the board of directors of a corporation and it operated in that way.

You did not give detailed instructions but you set the general pattern and the policy, and you discussed major activity and the Director sought the guidance of the Board. Whether this was by tradition or by law I am not sure but I know they did operate as really the top governing body.

Mr. FELDMAN. In fact I used that very illustration to point out that the NACA function of the Board is in the nature of a board of directors but under the new setup where the Director is on top and the Board is purely advisory. Because the proposed Board only has the power to recommend, then we lose that identity of the Board remaining a board of directors. What are your views regarding this change?

Dr. FURNAS. I would say as a practical matter to me it is obvious that whatever legislation was set up for NACA has worked satisfactorily. I feel that the same language should serve for this new Agency.

The CHAIRMAN. On the question of responsibility do you think you would get more direct responsibility from a 17-man Board operating than 1 man? A 17-man Board can do it if they want to. They have complete authority. If they did not do it that is their fault?

Dr. FURNAS. The effectiveness of a 17-man Board will depend on how judiciously they use their authority. If they begin using this authority in every minute detail it simply won't work.

The CHAIRMAN. Under the original act they could if they wanted to.

Dr. FURNAS. They could; yes.

Mr. FELDMAN. It is like cooperating with a board of directors. The board of directors wants to set the policy.

It gives the orders to the president and the president is supposed to carry out those orders. The test is usually what the figures are at the bottom of the line at any given period to see how effectively he is carrying out those instructions.

Mr. FULTON. Would the gentleman yield on that point?

Mr. FELDMAN. Yes.

Mr. FULTON. Do you feel that giving the National Space Agency a tremendously expanded field would call for full-time people rather than part-time advisory committee members who meet possibly 4 or 6 times a year, and do the job as a side issue?

Dr. FURNAS. I feel, and this again is partly because of the success of the other pattern, that this Board meeting occasionally is the better way to do it. If you are going to have it full time, this comes over to the Commission structure, which I feel is necessary when you have a regulatory function.

But, if you have this Commission structure which is full time, then they will begin to get into operating details, and I don't think this is the best way to run a research and development organization.

Mr. FULTON. With a commission structure, we could set up by legislation that they have an advisory consulting board, just as many other Government agencies do at the present time; could we not?

Dr. FURNAS. It is possible. The advisory boards are useful but they are not as effective as the NACA. I feel that the NACA structure, with certain well-defined responsibilities—and actually meeting directly four times a year is too few. I do not feel that is an appropriate way to do it.

Mr. FULTON. That is all.

Mr. FELDMAN. In response to Congressman Fulton's question you stated the agency has regulatory functions. Would not this new agency have regulatory functions?

Dr. FURNAS. I do not think it would have.

The CHAIRMAN. What about licenses?

Mr. FELDMAN. Would they be any less regulatory than the Atomic Energy Commission?

Dr. FURNAS. Yes.

Mr. FELDMAN. You talked before of the fact they have the safety problem in the Atomic Energy Commission.

Dr. FURNAS. That is correct.

Mr. FELDMAN. Do you envision the fact that there may be great safety factors involved in connection with the launching of missiles?

Dr. FURNAS. This will be part of the military function as I see it. It may be part of the Weather Bureau sometime or it may be part of the National Science Foundation.

Mr. FELDMAN. If this expanded organization is to go into the development of new missiles or new satellites or new vehicles that will go into outer space, will they not involve grave danger factors?

Dr. FURNAS. Not grave danger factors; no, sir.

Mr. FELDMAN. They could involve because of the use of these exotic fuels and things of that sort. Won't they have to regulate?

Dr. FURNAS. I don't visualize they will have to regulate except for their own internal regulation.

Mr. FELDMAN. There will not be any concern if you establish a new site in the interior of the United States or any place in the United States, you won't have to have regulations?

Dr. FURNAS. Not in the sense that the AEC has to have regulations on the safety of the use of fissionable materials, no, sir.

Mr. FELDMAN. These exotic fuels are pretty dangerous and have to be used properly and you have to have regulations concerning them, do you not?

Dr. FURNAS. As far as the launching sites are concerned, yes, sir.

Mr. FELDMAN. And there may be a lot of launching sites. We are talking about, for example, a million-pound thrust engine, the launching of a satellite from an engine of that kind which might certainly be one involving health and safety?

Dr. FURNAS. Not to the extent of the hazards of fissionable material.

Mr. FELDMAN. Well, the danger may not be as great but it still requires some regulations, is that not so?

Dr. FURNAS. Not in the national sense, no, sir, I don't think it does.

Mr. SISK. Would the gentleman yield again?

Mr. FELDMAN. Yes, sir.

Mr. SISK. We had testimony before this committee about the danger of dirtying up space with too many satellites. Very frankly this was proposed as I recall in good faith, that it might need some regulations. I am curious to know if you have any comment as to the regulations concerning that feature?

Dr. FURNAS. I certainly cannot get frightened with having too many satellites up there, there is an awful lot of space.

Mr. FELDMAN. Would it control who goes up in outer space? Would you let anybody go up?

Dr. FURNAS. I don't see any reason to prevent them at the present time.

Mr. FELDMAN. Won't there be some traffic problems?

Dr. FURNAS. No, sir.

Mr. FELDMAN. Never?

Dr. FURNAS. I do not visualize it, no.

Mr. FELDMAN. Aren't we in the same relative position as we were at the time of the development of the airplane when we did not have the need for traffic problem?

Dr. FURNAS. The NACA has done a very effective job in the research end, but they have not done anything in the regulatory end. If we are going to have regulations of the Space Agency it should not be NASA.

Mr. FELDMAN. What about communications? We are giving them this expanded authority where they can go into all these fields.

Dr. FURNAS. If you are talking of allocation of wavelengths this is the job of FCC and they have to use certain bands.

Mr. FELDMAN. Won't they have to come to this new Agency?

Dr. FURNAS. No, the FCC will regulate the allocation of bands.

Mr. FELDMAN. In outer space?

Dr. FURNAS. Yes, because the radiation is coming in from outer space. It is simply a matter of interference with communication. In general, I would hate to see this new Agency get into the regulatory business.

The CHAIRMAN. Doctor, I can appreciate your answer to the immediate situation but we have to project our minds ahead and see what the law of natural consequences probably might be.

Dr. FURNAS. I think there will be plenty of time, sir, for additional legislation if that is required.

The CHAIRMAN. I take it then from your testimony you do not think much of this new Agency, do you?

Dr. FURNAS. Yes, I think a great deal of this new Agency.

The CHAIRMAN. In other words, you think 10 or 15 or 20 years from now after the military has done its operating, then what flows from the military activities to be used for peaceful purposes might be then drifted over to the civilian side of the Government. I would take it that is the substance of your mind?

Dr. FURNAS. No, sir. In the foreseeable future I don't see any lessening of the necessity of the military development.

The CHAIRMAN. I agree with you on that. When I analyze what you say I am wondering what is left of this new Agency.

Dr. FURNAS. All of space.

The CHAIRMAN. I know but the military has taken all of that now.

Dr. FURNAS. No, sir. This is to do the essential background research and development for this and the military applications. Specific military application will be the role of the military.

The CHAIRMAN. I know, but the role of the military today could almost be 100 percent, could it not? What is left of this new Agency is what I would like to know?

Dr. FURNAS. There has been a tremendous amount and there is still a tremendous amount in conventional aeronautics if we might use the term, at the present time for NACA and it has been the backbone of a great deal of military developments in aircraft and in missiles too.

The CHAIRMAN. That is upon permission of the military, when they ask them to come in and cooperate with them, is that right?

Dr. FURNAS. That is correct.

The CHAIRMAN. Of course, the NACA cannot get into the military research unless they ask the NACA, or the new Agency, to do so. I am wondering what original jurisdiction this new Agency will have once it is established?

Dr. FURNAS. It will have the jurisdiction of the background research and development in the exploration of space.

The CHAIRMAN. But the military, according to your testimony, is primarily interested in that and the biggest part of that is going to be connected today, tomorrow, and in the foreseeable years with the military. I am not arguing against that now. I am trying to project my mind and analyze what is left of this Agency as a matter of original jurisdiction.

Dr. FURNAS. I think it is a matter of the original jurisdiction, very much the same as it has been in aeronautics since 1915.

With respect to my statement on the role of the military, I felt that if there are areas of background and fundamental research which are probably going to be of interest to the military and it will not be

covered, then the military should undertake that itself. But I anticipate that the Agency will plug the holes quite well if given proper support.

The CHAIRMAN. What holes will be left as a matter of original jurisdiction?

Dr. FURNAS. This Agency will be the one which will have that original jurisdiction.

Mr. McDONOUGH. Along that thought, do I understand you to mean, Doctor, that this Agency will be the agency for basic research and development in astronautics and will not be an operational agency?

Dr. FURNAS. No, sir; it will not be an operational agency.

Mr. McDONOUGH. It will not be?

Dr. FURNAS. It will not be.

Mr. McDONOUGH. It is strictly a research and development agency?

Dr. FURNAS. That is right.

Mr. McDONOUGH. For the purpose of coordinating the men, physicists, and scientists who are devoted to that under its jurisdiction?

Dr. FURNAS. Yes, sir.

Mr. McDONOUGH. Both in the civilian pursuits and in military expansion.

Dr. FURNAS. They will not have any authority over the military. They certainly will deal in subjects which are of interest to the military.

The CHAIRMAN. Who would be the operating agency if we can ever get into this peaceful side? Who will be the operating agency?

Dr. FURNAS. For the military?

The CHAIRMAN. I a m excluding the military now. Who will be the operating agency? You say it is confined to research and development. There will be something beyond that sometime, will there not?

Dr. FURNAS. I anticipate that there may be some Weather Bureau activities at sometime just as the Weather Bureau operates weather ballons. Whether this will be used as transport or not I do not know. If it does come to commercial transport it will come under the CAB and CAA.

Mr. KEATING. May I ask a question on that point? Dr. Furnas, under the wording of this bill, whether it is right or not, I think it is operational because we are giving them the authority to acquire, construct, improve, repair, operate, and maintain laboratories, research and testing sites and facilities, manned and unmanned aeronautical and space vehicles. This agency is given by this bill authority to operate a fleet of space vehicles. Whether we want to do that or not is another question, but under the wording of this, in my judgment, that language is not capable of any other interpretation.

Dr. FURNAS. Perhaps I am getting the wrong slant on the semantics of operation here. The necessary operation to carry out a research and development program, yes. But operation as military weapons, no. Operations for commercial transport, no. Operation as a function of the Weather Bureau for long-range weather predictions, no.

Mr. KEATING. But I think if we are going to negative that authority, we would have to add something to this language because this is in a separate section from the one talking about development.

This is the broad authority to operate the McCormack Space Vehicle Corporation to the stars, and I do not think you can limit the language unless you put some more in there.

Dr. FURNAS. Perhaps, sir, if you put in a phrase, the language there for research and development purposes.

The CHAIRMAN. Mr. Fulton has a question he wants to ask. Mr. Fulton.

Mr. FULTON. Who in your theory would launch a space vehicle for peaceful purposes, whether for an exploration of space experiment or testing the type of vehicle?

Dr. FURNAS. Certainly this new agency, the NASA could do that. I think there might be launching by contractors of the National Science Foundation, for instance.

Mr. FULTON. But you would let NASA operate, for exploration of space, a peaceful space vehicle?

Dr. FURNAS. Certainly. This would be part of their function, whatever operation is required in this research and development function. This is the operation we are talking about; yes.

Mr. FULTON. You have research and development of the structure and you also have exploration of the space?

Dr. FURNAS. That is correct.

Mr. FULTON. One is Columbus and the other is von Braun. Now would you have our future Columbus of America operate under NASA?

Dr. FURNAS. He might.

Mr. FULTON. So that he would really be an operating explorer?

Dr. FURNAS. Yes, sir; you have to get out there if you are going to explore space.

Mr. FULTON. Then when we go into this radical, free radical program of yours and establish a powerplant against the opposition of the gentleman from Montana, who is for H_2O and not O_2, who is going to do that, this NASA Agency?

Dr. FURNAS. Yes; I think this would be a very appropriate function.

The CHAIRMAN. Did I hear you say rightly a moment ago that the National Science Foundation would shoot one of these peacetime satellites in the air?

Dr. FURNAS. I think they might very well do that.

The CHAIRMAN. What do you want to have another agency for? What is the use if they are both going to do it? If we are going to establish an agency we ought to give them some authority or jurisdiction.

Mr. MCDONOUGH. You must have basic research before that is done. As I understand the doctor and as I see it, the National Aeronautics Administration at the present time is a source for advanced aeronautics, that private industry has not yet tested. This agency is for the purpose of studying basic research for advanced astronautics that only the Government up to now has been interested in and private industry later may be interested in.

The CHAIRMAN. The doctor just said a moment ago, if I understood him correctly, that the National Science Foundation, in response to Mr. Fulton's question, could shoot one of these peacetime satellites in the air. Is that correct?

Dr. FURNAS. I think it might well be within their function.

The CHAIRMAN. Then if we establish this new agency, it can do it, too?

Dr. FURNAS. Yes, sir.

Mr. FULTON. You would not have passports for outer space, would you?

The CHAIRMAN. You also say the National Science Foundation has the authority now to do it and should do it in addition to the new agency?

Dr. FURNAS. Of course, the National Science Foundation is only a contracting agency. This would be one of their contracts. If it is one of the projects which they are supporting, with a research organization which calls for sending a satellite up into outer space, I do not see any reason why they should not.

Mr. SISK. Would the gentleman yield?

The CHAIRMAN. I am not arguing that, but I am trying to get in my mind these two agencies. We are likewise terminating an existing agency with too limited jurisdiction in the world of today and establishing a new one with broader jurisdiction. If we do that it seems to me that we ought to confine the jurisdiction to the one agency so far as this outer space activity is concerned.

Dr. FURNAS. I think that would be unduly restrictive sir.

The CHAIRMAN. Mr. Metcalf?

Mr. METCALF. Is the Weather Bureau going to send up a weather satellite at the same time?

Dr. FURNAS. I visualize they may.

Mr. METCALF. So there is another agency?

Dr. FURNAS. I would say it is analogous to what the situation would be if we had the restriction that only the Atomic Energy Commission could have any nuclear reactors. I think this would be highly restrictive. This was essentially the attitude initially but we have certainly gotten away from that.

The CHAIRMAN. But the Atomic Energy Commission has jurisdiction over that, does it not?

Dr. FURNAS. Only in the safety aspect.

The CHAIRMAN. The Congress passed a law connecting it with the AEC. It came out of the Joint Committee. All of that is regulated and under control of the Atomic Energy Commission, the grants, subsidies and all that in connection with these peacetime reactors. It is all connected with one agency though, is it not?

Dr. FURNAS. This, of course, ties back to the security aspect and being built of material and also with safety.

The CHAIRMAN. I am not arguing in the field of private industry. I am talking of control and jurisdiction.

Dr. FURNAS. I hope that this NASA does not get into the regulatory aspects. I think it will hinder their research projects.

The CHAIRMAN. We have gotten into the hardware angle now.

Mr. NATCHER. Doctor, you agree that the NACA is an operating agency?

Dr. FURNAS. It only operates the equipment and the facilities for its research function.

Mr. NATCHER. I agree with that. When Doctor Dryden appeared before our committee he very emphatically stated that the NACA is an operating agency, it is not an advising agency. Now you agree with that?

Dr. FURNAS. In the research and development field, yes, sir.

Mr. NATCHER. That is all.

Mr. SISK. There is a point I would like to explore then. Doctor, maybe I am thick headed but I think we are just spinning our wheels. You indicated a little while ago that the only purpose in changing the format of the NACA was to broaden its scope a little bit in view of the fact it would be confined to aeronautics, and we want to get it into astronautics.

Now you say the National Science Foundation has authority to get into this field and the Weather Bureau has authority to get into it. I don't see but what we are wasting our time. The NACA has the same authority and jurisdiction to get into it as the National Science Foundation, would it not? So that it seems to me that if we assume your position, Doctor, we have just been wasting an awful lot of time. That is my summation of the situation.

Thank you, Mr. Chairman.

Mr. KEATING. Mr. Chairman, I do not agree with the gentleman from California. I do not want my silence to be taken as agreement because I look upon this as very important.

The CHAIRMAN. The Chair will say that silence does not constitute consent.

Mr. KEATING. I do think we have put a finger on a very important matter as to how far we are going to allow this agency actually to operate because under page 7, subdivision 3, NASA is given wide operational authority in my judgment, not limited to research and development; they can even run a cafeteria under this subsection 3, which is certainly getting into operation fields.

I think we have to give a lot of thought to that section.

Mr. MCDONOUGH. It is just a function that would be necessary for any agency.

Mr. FULTON. The McCormack Astronautical Co. will not have to worry about overhead.

The CHAIRMAN. Are there any further questions of the doctor? You have stimulated some discussions.

Dr. FURNAS. I am sorry, Mr. Chairman. I apparently have confused a lot of people on the subject.

Mr. FELDMAN. I just have one more question to ask. I ask this because of the fact that you did serve on the NACA, that is on the Advisory Board or the board of directors, so to speak.

What percentage of work did the NACA do for the military that was military in nature?

Dr. FURNAS. On request from the military or of military importance?

Mr. FELDMAN. I mean of military importance.

Dr. FURNAS. I would say that probably 75 to 80 percent of the work was of military importance. It might even be higher than that. But this is very hard to define.

Mr. FELDMAN. Do you envision that when this agency is taken over by the NASA that those facilities would continue?

Dr. FURNAS. Yes, sir; for the foreseeable future this would be a large proportion of military importance.

The CHAIRMAN. Let me see if I get this clear now. Under this Agency they will have the authority to make contracts, if desired, with private companies?

Mr FURNAS Yes.

The CHAIRMAN. To do basic and applied research in connection, say, with a satellite going up into the atmosphere. You admit that they should have that power?

Dr. FURNAS. Yes, sir.

The CHAIRMAN. And at the same time the National Science Foundation should have the same power?

Dr. FURNAS. Yes, sir; if their program justifies it. I might add at this point that the effectiveness in avoiding undue duplication is going to depend primarily upon this committee or board. The membership should be made up so that you have representation of these various major activities so that you get ability in coordination.

The CHAIRMAN. I see the separation or the difference between the military at this time in the world's history clearly. But these are two civilian activities, primarily for peacetime purposes. You say they both should have this jurisdiction to compete with one another.

Dr. FURNAS. No; they should act complementary.

The CHAIRMAN. Which should be the major one?

Dr. FURNAS. As far as the amount of money spent on astronautics, the NASA should be the major one.

The CHAIRMAN. If you were to say that the NASA could make a contract with the National Science Foundation to carry out certain research work, either basic or applied, I could see the difference, but for the National Science Foundation to have original jurisdiction after we set this up in the initial stage, that is where it is difficult for me to reconcile.

If you mean the latter, I can understand that.

Dr. FURNAS. I feel that it would be a mistake to have legislation that confines all astronautical research to the NASA just as I think it would be unwise to confine all nuclear research to the AEC.

The CHAIRMAN. What other agencies are doing nuclear research besides the AEC, I mean outside of the military?

Dr. FURNAS. Various companies and various universities, various research foundations.

The CHAIRMAN. I can see a difference there but the Government has the benefit of their discoveries, does it not?

Dr. FURNAS. Not necessarily; I mean there are private companies that are doing nuclear research.

The CHAIRMAN. But in connection with Government contracts the Government gets benefit, does it not?

Dr. FURNAS. Yes, sir, if it is a Government contract that is part of your contract provision.

Mr. McDONOUGH. Speaking about the Weather Bureau operating independently or releasing a satellite, even before we released a satellite they had released balloons for checking weather conditions into outer space, had they not?

Dr. FURNAS. I have forgotten the altitude but they have sent some up quite high, 100,000 feet or so.

Mr. McDONOUGH. So that we have been exploring outer space or the upper atmosphere?

Dr. FURNAS. Yes, sir; the fringes of the atmosphere.

Mr. McDONOUGH. So as I conceive your opinion of this Agency it should be the parent agency from which the basic research on astronautics should originate?

Dr. FURNAS. Yes, sir.

Mr. McDONOUGH. And the discoveries of the Government or the military would be available to private industry for peaceful uses?

Dr. FURNAS. That is correct

Mr McDONOUGH. That is simple. It is a very important Agency in my opinion for that reason. There is no other agency that can do it.

The CHAIRMAN. You said the parent organization. You mean in relation to the National Science Foundation, for example?

Mr. McDONOUGH. Yes.

The CHAIRMAN. I am talking about the satellite going out in the air.

Mr. McDONOUGH. The National Science Foundation should seek from this Agency the authority, the regulation, the license, the privilege of moving.

The CHAIRMAN. That is different. Now you have come to my point. Is that what you meant, Doctor?

Dr. FURNAS. No.

Mr. FELDMAN. Doctor, I have just this one question. Under the type of agency that you envisage why do we need a new law to accomplish what you have in mind? Why cannot the NACA as presently set up do everything that you want done within the limit and scope that you want it done?

Dr. FURNAS. Because I think its assignment has been too restricted for this.

The CHAIRMAN. All the President would have to do is put a reorganization plan through just demoting the Board below the Director, appointing a director.

Mr. METCALF. Not even that, an Executive order.

The CHAIRMAN. I think so but I would not go quite so far as that.

Mr. McDONOUGH. I should imagine he has the authority now any way.

The CHAIRMAN. I will not go quite as far as that now, but I won't argue against one who says that.

Mr. KEATING. NACA has not anything to do with outer space.

Mr. FELDMAN. They are doing it. Doctor Dryden testified here that about 15 percent of their work last year was in outer space and that in 1959 their program calls for 25 percent.

Mr. McDONOUGH. The Weather Bureau is investigating upper atmosphere also.

The CHAIRMAN. Are there any further questions?

Mr. SISK. I would like to say one thing. I do not think there is any difference of opinion between myself and the gentleman from New York with reference to what the bill does and in reference to what we have in mind. On the other hand I do feel that should we follow the doctor's suggestion then I think we have been spinning our wheels.

I want to clarify that.

The CHAIRMAN. I agree with Mr. McDonough but the doctor does not wholly agree with Mr. McDonough.

Doctor, it has been very interesting. We ask questions oftentimes in the nature of a devil's advocate and they do not necessarily reflect our state of mind. You understand that?

Oftentimes it is from the pressing questions that the members of the committee get the most valuable information. I make that statement so that it is clearly understood that while I have asked what I thought were some pointed questions—I don't know whether

they are interesting questions, they concern me—they do not necessarily represent my state of mind.

Thank you very much. We have enjoyed having you with us. So the committee will adjourn now until 2 o'clock.

(Whereupon, at 12:55 p. m., the committee adjourned, to reconvene at 2 p. m., the same day.)

AFTERNOON SESSION

Mr. McCormack. The other members will come in, gentlemen, later. So we will proceed.

I notice that Dr. DuBridge and Dr. Pickering, both of whom we know are outstanding scientists and dedicated men come from and are connected with the California Institute of Technology.

I like to make this as informal as possible. And don't have any hesitancy in collaborating with one another.

Dr. DuBridge. Thank you.

Mr. McCormack. We want as frank expressions of views as you can give. Any question asked which involves an answer which involves classified information we want you gentlemen to just simply state so.

We are glad to have you with us, Dr. DuBridge.

The next witness is Dr. Lee A. DuBridge, president of the California Institute of Technology, Pasadena, Calif.

Mr. Keating. Before he states, may I again stake out a claim?

Dr. DuBridge was head of the physics department of the University of Rochester for a number of years before becoming president of the California Institute of Technology. And he is a distinguished scientist.

I need not tell you or the members of this committee that.

But I am particularly gratified to be on a committee where he is going to give us the benefit of his great knowledge and wonderful experience.

Mr. McCormack. I am sure we will benefit by his presence.

Mr. McDonough. Let me say, California is proud of that fact.

Dr. DuBridge. I was born in Indiana. Isn't there somebody from Indiana here?

Mr. Chairman, may I make one suggestion since my interest and whatever small competence I have in the field of space research comes from the fact that one of the divisions of California Tech is the jet propulsion laboratory which we operate under an Army contract for the Government and which has been responsible for collaborating with the Army Ballistics Missile Agency in the launching of the two Explorer satellites.

The Director of our Jet Propulsion Laboratory, Dr. Pickering, is here with me, and though we haven't collaborated on our testimony, I think our remarks will supplement each other.

May I request that immediately after my prepared statement he give his statement, and then that questions be directed to both of us and then we will share the questions between us, if that is all right with you.

Mr. McCormack. That will be agreeable.

STATEMENT OF DR. LEE A. DuBRIDGE,[20] PRESIDENT, CALIFORNIA INSTITUTE OF TECHNOLOGY

Dr. DuBridge. It is an honor to be invited to present my views on the future of space research to this committee.

The actions which the Congress will take during the coming weeks on this issue will decisively determine the role which the United States and the free world will play in this exciting field.

I suppose that the dream of "flying to the stars" has been dreamed by men ever since men have been able to dream at all. But it was not until the time of Isaac Newton that the essential physical conditions for leaving the earth were first understood. Newton himself did point out, however, that if air resistance could be eliminated then a stone hurled horizontally from a high mountain might circle the earth forever.

Newton knew also how to calculate the velocity required—by the simple process of equating the gravitational force on the object to the centrifugal reaction. For over 200 years men have been trying to lift objects high enough above the earth to get away from atmospheric friction, and then to hurl the objects with the colossal speed of about 5 miles per second which Newton's law requires.

It became clear in 1955 or earlier that modern rocket technology had advanced to the point where this feat could now at last be achieved. And it was also agreed that during the International Geophysical Year program both Russia and the United States would attempt to launch earth satellites for the purpose of obtaining scientific information.

As you know, both nations have now achieved that objective; hurling objects into orbits around the earth is no longer a dream. Objects will soon be hurled to the vicinity of the moon and before long to other parts of the solar system.

Getting beyond the solar system—out to other stars, for example—will remain still, a dream, for a long time to come for two reasons:

(1) The velocity of escape from the solar system—for an object which has escaped the earth's field—is about 26 miles per second. It takes 15 times as much energy to escape the sun's gravitational field as to escape the earth's field alone;

(2) After escaping from the solar system, it would still take 10,000 years for an object to reach the nearest star if we could again get up to a speed of, say, 18 miles per second. Stated another way, if we could give an object five times the speed—of 7 per miles second—required to leave the earth—for example, 25 times the energy—it would still take over 10,000 years to reach the nearest star.

[20] DuBridge, Lee (Alvin), physicist, born Terre Haute, Ind, Sept 21, 1901; s. Frederick Alvin and Elizebeth Rebecca (Browne) DuB, A B, Cornell Coll., Ia, 1922, Sc D, 1940, A M., U. of Wis., 1924, Ph. D., 1926, Sc D, Wesleyan Univ, 1946, Brooklyn Poly, 1946, Washington U., 1948, U. B. C., 1947, Occidental Coll, 1952: LL. D, U Cal, 1948, U Rochesei, 1953, m. Doris May Koht, Sept. 1, 1925: children—Barbara Lee, Richard Alvin Asst in physics, U of Wis, 1922–25, instr, 1925–26, fellow Nat. Research Council at Calif Inst Tech., 1926–28, asst prof. of physics, Washington U., St Louis, 1928–33, asso. prof., 1933–34; prof. of physics, U. of Rochester, 1934–46, dean faculty arts and sciences, 1938–41, investigator, Nat. Defense Research Com, dir. radiation lab, Mass. Inst Tech, 1940–45, pres. Calif. Inst. Tech., since 1946. Bd. Trustees, Rand Corp, Santa Monica, Calif., since 1948 Mem gen adv. com. A. E. C., 1946-52; Naval Research Adv. Com., 1945–51, Air Force Sci. Adv. Bd, 1945-49; mem President's Communications Policy Bd., 1950–51; mem. Nat. Sci Bd, 1950–54, chmn. sci adv. com O D. M. since 1952. Trustee Nutrition Found, Carnegie Endowment for Internat Peace. Received Research Corp. Award, 1947. Medal for Merit (U S.), 1948, King's Medal for Service (British), 1948 Fellow Am Physical Soc. (v. p. 1946, pres., 1947), Am Inst. Radio Engrs, mem Nat. Acad Sci, American Philosophical Society, A. A. A. S., Optical Soc. Am., Assn. Am Physics Teachers, Nat Research Council (1936-46), Am. Assn. Univ. Profs., Phi Beta Kappa, Sigma Xi, Tau Kappa Alpha, Tau Beta Pi Presbyn. Author: Photoelectric Phenomena (with A. L. Hughes), 1932 New Theories of Photoelectric Effect, 1935. Contbr numerous scientific articles to physics jours Home. 415 S. Hill Av., Pasadena 4, Calif.

Other stars are from 10 times to one-half billion times farther away still.

We will thus do well to stay in the solar system for the present. Thus, while we rejoice at the achievement of getting outside the earth's atmosphere for the first time, we have taken only a very tiny step into real outer space.

Yet, getting outside of the earth's atmosphere has enormous scientific advantages:

1. It lets us look at the moon, the planets, and the stars for the first time free from the blanketing effect of the air. This means we can—if we can obtain stable platforms and accurately guided telescopes—secure images free of distortion or "fuzzing" produced by air currents, and can also receive all the ultraviolet, infrared, X-rays, and radio waves now cut off by the atmosphere.

2. It allows us to look down—with our instruments or cameras—on the earth from above the air, thus seeing a large segment of the earth all at once, and getting for the first time a comprehensive view of the clouds and weather patterns as seen from above. As the earth rotates under the satellite orbit, it will have a view of the whole earth every 24 hours.

3. Outside of the earth's atmosphere we will get a new look at the earth's magnetic field, the cosmic rays, the gravitational field of the earth and the earth's exact shape and size, the radiations from the sun that presumably cause the aurora and other atmospheric effects and possibly have some effect on the weather.

In short, the possibility of having satellites taking instrumented observations at distances of from 200 to 2,000 miles above the earth's surface opens up many new fields of scientific exploration. That is the reason, of course, why a satellite program was included in the plans for the International Geophysical Year and why scientists are now so anxious to continue a large-scale satellite program.

I should like to commend to you the report of the technical panel on the Earth Satellite Program of the United States IGY Committee.

Because this sets forth the scientific exploration program that scientists have thought about carefully, I believe is a solid and useful, important program.

Mr. McCormack. How long a report is it?

Dr. Pickering. Six or eight pages.

Mr. McCormack. If there is no objection, at the conclusion of your statement we will make it a part of the record.

Dr. DuBridge. Thank you, sir. It was published in full in the New York Times. It is published in a recent issue of Science Magazine. So it is easily available.

It should be emphasized that while there are many phenomena which we know a good deal about and wish to measure more accurately far above the earth, there may be a number of wholly unforeseen phenomena which we might encounter and which will be of surpassing interest.

It is hardly fruitful to speculate as to what these unknown things might be, but the history of science is replete with examples of the new discoveries resulting from a new advance in the technique of observing or the opening up of new kinds of observations.

I think next week the International Geophysical Year Committee is going to release the results of some of the programs, some of the

information that has been obtained with the existing Explorer and Vanguard satellites.

I hear from advance rumors—but I am not in a position to give the details—that quite new things have been obtained by the cosmic ray instruments and quite unexpected results are being revealed by the Geiger counters used for cosmic-ray measurements.

This might be quite an important new thing that is being uncovered. We can expect many unexpected new things.

In my view the predominating and overpowering reason for developing a substantial program of space exploration is the vast new extension in our knowledge which this will yield and the great value which this knowledge is certain to have as it is applied, as time goes on, to the practical problems of human welfare.

However, the results of exploring space go beyond the purely scientific. It is not a matter of breathless interest to the scientist to know what the other side of the moon looks like. There is no reason to suppose that the other side hides any great new undiscovered phenomenon of nature.

Nevertheless, no human being can avoid being curious about what the other side of the moon does look like.

Man's curiosity will never be satisfied until he has a picture of it or until he actually sees it.

Mr. McDonough. The moon does not revolve.

Dr. DuBridge. It does But it revolves at the same speed that it rotates around the earth. The speed of rotation about its own axis is exactly the speed of the rotation around the earth.

Mr. McDonough. Is that the only planet that does that?

Dr. DuBridge. Yes. Well, it is really a satellite of a planet, of course. Some of the other moons of other planets may do this, we don't know.

This is not exactly accidental. This has come about because of the fact that the moon's own rotation about its own axis is damped out by the tidal friction, the loss of energy due to the tides.

This has reduced the moon's rotational velocity until it happens to match its orbiting velocity.

Mr. Feldman. Isn't that true of Mercury too?

Dr. DuBridge. No, I don't think so.

Well, we may not know. It is conceivable that other satellites around other planets might have come to the same condition.

This is the final stable condition.

(Editor's note· According to the World Almanac, Mercury always turns the same face to the sun.)

Mr. McDonough. I don't understand this control of the tides.

Dr. DuBridge. Not control. You know that the tides are produced by the moon's gravitational influence.

Mr. McDonough. On the earth.

Dr. DuBridge. Yes.

Mr. McDonough. Yes.

Dr. DuBridge. And these tides involve a very large expenditure of energy. Energy is being dissipated in the tides. As the water rises and falls this means a dissipation, a loss of energy. This energy has to come from some place. It comes primarily from the moon's own rotational energy.

Mr. Keating. Has it always been that way?

Dr. DuBridge. Of course.

What do you mean "always"? Four and a half billion years?

Mr. FELDMAN. What was it before then?

Mr. DUBRIDGE. We think the solar system was created about 4½ billion years ago. So it is only since then.

Mr. FULTON. Obviously the atmospheres around the earth and the moon revolve too.

Now, do the atmospheres——

Dr. DUBRIDGE. Of the earth. It goes with the earth.

Mr. FULTON. Yes.

Dr. DUBRIDGE. Yes. All right.

Mr. FULTON. Is there any place where it moves less fast?

Does the atmosphere just go at the same speed?

Dr. DUBRIDGE. Yes.

Mr. FULTON. Where does that stop, then?

Dr. DUBRIDGE. The top of the atmosphere?

Mr. FULTON. We don't know where the end of that is, do we?

Dr. DUBRIDGE. The atmosphere trails off exponentially. But I think you could say 500 miles above the earth the number of molecules is so small that the atmosphere is no longer there. And that there would be at that height be no longer any relation between the motion of the individual molecules and the motion of the rotation of the earth.

Mr. FULTON. Jet streams around the earth's surface of the high winds are not caused by the atmosphere slipping in.

Dr. DUBRIDGE. No. No reason why it should slip. Once it gets started, it keeps on going. But the earth's rotation plays a part in these high atmospheric currents.

Mr. FULTON. That is really what I meant.

Dr. DUBRIDGE. Because once you get a motion started, say, at the North Pole, as air flows toward the South Pole, it flows into a region where the velocity of rotation is greater.

That is the speed required to go around is greater. This means a centrifugal force that diverts the air currents and causes them to divert themselves into curious patterns.

Mr. FULTON. So it is the centrifugal force and not the slipping of the atmosphere?

Dr. DUBRIDGE. Yes.

Nor will it likely add anything to scientific knowledge when a man first travels in space. Yet we are all curious to know what space travel feels like, how a man will react to the weightlessness and other unaccustomed environment in a space vehicle—and there are many people who can hardly wait to get a "look-see" at the region beyond our atmosphere, even to the farthest reaches of the solar system.

In other words, in addition to the pure scientific interest in space there is the explorer's interest—the interest in satisfying human curiosity and human yearning. These things are important—they have been a prime urge toward human progress for thousands of years. And no one dares to say that these explorations will not yield unexpected knowledge of great value.

This weightlessness that is talked about, many people think that is due to the fact that a satellite is outside the earth's gravitational field. This is of course not the case. The earth's gravitational field is not very much less at 200 miles than it is at the surface.

Even with a thousand miles it is only 40 percent less.

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The weightlessness in a satellite is due to the fact that the gravitational pull is exactly balanced by centrifugal force or centrifugal reaction so the two exactly compensate.

So the net result is that the net weight is zero. But there is a gravitational force compensated by a centrifugal reaction which gives a net zero amount of weight.

Thus we should add to the scientific interest in space the explorer's interest.

These two are connected but slightly different. One could send an expedition to take measurements at the top of Mount Everest. But most explorers that have gone to the top of Mount Everest have not had scientific knowledge as their major objective.

We must also face up to the fact that during the next few years the nation that leads in the exploration of space will also gain great international prestige. I think we should be careful not to exaggerate this factor—but we should not minimize it either. The astounding impact which the first sputnik had on world opinion was a stunning surprise and shock to the American people—and indeed to our friends around the world.

However, now that five satellites have been successfully placed in orbit, the great shock of the first one has passed and it is unlikely that future space ventures will have anything like the impact of the first sputnik. Everyone knows now that sooner or later a satellite will be placed in an orbit that goes out into the vicinity of the moon. But that achievement—just because it is expected—will hardly cause the stunning shock, and hence the great propaganda victory, which Sputnik I produced.

At the same time we cannot deny the fact that if America neglects to exploit the possibilities of space exploration while Russia moves rapidly ahead our prestige will seriously suffer.

While there will be substantial propaganda advantages in carrying out a bold and an original program we must remember that we cannot expect to do everything first.

There are many things to be achieved in this field. Russia may go quietly ahead in some project they know we are not working on and therefore beat us to it once more. We should be prepared for this.

But we should move ahead and try to attain a few first of our own.

Thus the propaganda values add a third reason for proceeding with space exploration.

Finally a fourth reason. We must consider the military values associated with space exploration.

Now it is terribly important that we think our way through this field with the greatest of care.

We must not neglect any possible military gain to be attained. But we must also not waste untold billions of dollars on fruitless adventures. No task is more difficult than that of being both bold and careful.

And yet in this area we must be both.

Now, let me say at once that I do not include the development of military ballistics missiles such as the ICBM and the IRBM as space developments. I am not thinking of those in terms of space research.

It is true the long-range missiles do penetrate into space well above the atmosphere and remain there for a brief time, a few minutes. And it is necessary that we know more about this space and the problems

of leaving it and returning to the atmosphere in order to do a better job of designing missiles.

But space exploration and space research for its own sake I should like to separate from the problems directly connected with military missiles.

For one reason I don't want anything to interfere with missile development, which is a very important military goal.

It is, of course also true that rocket technology which enables us to project military pay loads for distances of 5,000 miles or so on earth also enables us, as we now well know, to project satellites into earth orbits.

Missile research therefore will contribute to space research and no doubt the reverse will also be true. In short, no one should argue against the necessity of the defense agencies working on the many problems of space investigations which are clearly related to ballistic missile development in order to speed these missile developments themselves.

May we take that for granted and then talk about other space problems, the real exploration of space as a separate category from missile development per se?

Nevertheless the military services must do more than just the pure ballistical missile work.

An earth-encircling satellite, especially one of some size, might have quite important military applications. The possibilities of surveillance and reconnaissance for example are at once obvious. The use of satellite relay stations and various types of communication problems may be important. Weather observations are of course also of military interest.

There may be other applications of which I have not heard or which no one can now foresee. Certainly a program of research in this field by the military services is of great importance for we must at least keep alert to the possibilities which our potentials may be developing.

Having said all this, however, I think it is also important that we examine our military programs with some care. In the first place we must be sure that the glamour of Buck Rogers Adventures does not divert effort and talent from more important military projects, nor lead to the expenditure of vast sums of money on projects which will not contribute to our security.

There is no use denying there are some very alluring prospects in projecting vehicles into space. It is perfectly possible now to design and build rockets and guidance equipment which, Will put large objects into orbits around the earth and into orbits which will reach the vicinity of the moon or indeed actually strike the moon and later into orbits which will reach Mars or other planets.

The major questions to be asked are, What purposes do such devices serve and how much are we willing to invest to achieve these purposes?

Also we must ask how urgent some of these needs are and whether large extra effort and funds are justified to attain results more quickly.

Now, as I say, no one would deny that reconnaissance vehicles are of great military importance. They will help us learn much about space and about the earth. Military funds of substantial amount would be justified for a broad program for such purposes. What then about weapon launching satellites?

Here I feel that the answers are less clear. Our ICBM and IRBM weapon systems themselves are so promising and require still so much

attention that it is not clear that a weapon-launching satellite system would offer the great advantages which would justify a very heavy investment in this field.

A searching analysis of this question, however is surely in order and general research in this field is very much needed. But I call your attention to the fact that to get a weapon from a satellite or to get the satellite vehicle itself, including a weapon, accurately, reliably and quickly to a particular target on the earth is a most difficut and expensive operation. While the advantages of doing it this way are still very doubtful, at least I think they cannot be taken for granted.

We very quickly then reach the question also about whether or when we should plan to send manned satellites into space for presumed military purposes.

First we must ask what the purpose of the man is in the vehicle. Is it simply to give him a ride for the sake of the stunt, the adventure? If so, let's be honest about that and then we can decide how much such an adventure is worth to the taxpayer.

Is the purpose of the man to operate scientific instruments or to take scientific observations? If so, we must ask whether unmanned scientific instruments could do the job as well for less cost. And in many cases it will be found that a man contributes nothing or very little to what could be done with instruments alone.

And the cost of sending a man up on an extended trip including, of course, the cost of his food, water, oxygen, and all the other necessary requirements plus the considerable equipment required to bring him back alive, these costs may be very high indeed.

They may add several hundred pounds to the weight of the necessary payload and thus thousands of pounds to the required gross takeoff weight.

And an equal weight of scientific equipment might well yield much more valuable results in scientific experiments.

Now many rocket scientists and technologists are in favor of pursuing unmanned vehicle experiments for the present, saving the man for the time when his presence is absolutely necessary and really contributes something and also awaiting the time when improvements in reliability of rocket equipment will give the human being a better chance of returning alive. These considerations, of course, really apply equally well to scientific or military experiments.

We must also I think give more careful attention and critical attention to the various proposals being made for military bases in space.

Shall we assemble at colossal price a big space platform to be used as a base for further exploration and for military operations?

Shall we prepare at once to establish a military base on the moon?

I would like to say that when scientists speak of the conquest of space they mean the acquisition of knowledge about it, just as the conquest of the atom meant learning to understand it.

But some people apparently have taken the term "conquest of space" to mean military conquest. That we should promptly claim certain regions of space as having been captured by America, and that the United States Forces should capture the moon and hold it by military force.

Such notions I am inclined to think are likely to be dangerous for two reasons. First they may be impractical or useless or unduly expensive without adequate military worth.

And, second, very important, they may lead directly into military conflict with other nations, when we ought to be reserving outer space for peaceful international collaboration rather than as a locale for fighting.

A base on the moon, for example, it has been said by some to be a military necessity. I believe a careful study will show this to be unsound. It is clearly easier, cheaper, faster, more certain, more accurate to transport a warhead from a base in the United States to an enemy target on the other side of the earth than to take that same warhead, together with all the men and necessary auxiliary equipment to the moon and then shoot it back from there.

And what gain can possibly compensate for this enormous cost? I trust that the United States will take the lead in urging that outer space be used by all nations exclusively for peaceful purposes. All that I have been saying emphasizes that there are large tasks of peaceful scientific research and exploration to be carried on in outer space and that in many ways the extent and importance of these scientific tasks exceed that of the military aspects of space vehicles

Since we shall wish to be working extensively with other nations on the scientific aspects of space research, because we can make much faster progress if other nations join with us, it is desirable that the civilian aspects of space research be placed under a civilian, rather than a military, agency

So I favor the prompt creation by Congress of such an agency.

One thing about such an agency is that it will be able to avoid classifying or making secret many of the things about space exploration which ought to be open to all Americans and to all the world.

I should add, however, that if the Congress should create such an agency and then proceed to vote large funds for space research only to the military agencies, then it would be better not to create the civilian agency at all. If civilian space research is to be put under a civilian agency then that agency must be provided with adequate funds for the job.

There are some people who have predicted that Congress will vote most of the funds for the space research only to the military rather than to civilian agencies.

This, I think, would be tragic. But I also think that it is an unwarranted slur against the good sense of Congress. So I would like to urge then again the creation of a civilian space agency to do the civilian space exploration, to collaborate with other nations on international scientific exploration of space, and to take care of all of those aspects of space exploration which do not have direct and immediate military applications.

Thank you very much, Mr. Chairman.

(The report referred to on p. 775 is as follows:)

BASIC OBJECTIVES OF A CONTINUING PROGRAM OF SCIENTIFIC RESEARCH IN OUTER SPACE

UNITED STATES NATIONAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR 1957–58

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., February 14, 1958.

Memorandum

To: United States National Committee, the Technical Panels on the Earth Satellite Program and Rocketry Program, and Chairmen of All Other USNC–IGY Technical Panels.

From: Hugh Odishaw, Executive Director.

Subject: Report on Satellite Experiments.

Herewith is a copy of the study on satellite experiments in the form that it was submitted to the President of the Academy and the Director of the National Science Foundation. This provides a few minor revisions to the earlier draft.

BASIC OBJECTIVES OF A CONTINUING PROGRAM OF SCIENTIFIC RESEARCH IN OUTER SPACE

By the Technical Panel on the Earth Satellite Program of the United States National Committee for the International Geophysical Year, National Academy of Sciences

(NOTE.—Preprinted from the April 11, 1958, issue of Science, the weekly journal of the American Association for the Advancement of Science)

1. INTRODUCTION

The International Geophysical Year marks the beginning of man's exploration of outer space. There have been previous rocket firings into the fringes of the earth's atmosphere, but the expanded rocket-sounding program on an international scale and the advent of artificial earth satellites represent by far the largest steps taken toward the scientific exploration of outer space and the planets.

The interests of human progress and our national welfare now demand that a long-term program of space exploration be formulated and pursued by the United States with the utmost energy. Although there will inevitably be benefits from such a program of a very practical nature, the basic goal of this exploration must be the quest of knowledge about our solar system and the universe beyond.

The scientific program proposed here has been formulated with the following ideas in mind:

(i) Technology of space flight will probably develop gradually. Therefore, the payloads and distances traveled will be relatively small at first, and the scientific experiments and observations will be correspondingly modest in the early stages.

(ii) The scientific program should be designed to give information at each stage which will help in the planning of later flights.

(iii) Manned space flight will occur in the course of the program, but before this occurs certain crucial experiments must be performed which are aimed specifically at the design of a manned vehicle.

(iv) In the quest for outer space we must not lose sight of the tremendous implications to life on earth which the occupation of space will have.

The experimental program proposed in this study represents concepts and views of many scientists, but particularly those involved in the current IGY satellite effort. Of the latter group, the USNC–IGY Technical Panel on the Earth Satellite Program and its three working groups have in one way or another contributed to the thoughts expressed in this paper. The membership of these groups follows:

Technical Panel on the Earth Satellite Program: R. W. Porter (Chairman), G. M. Clemence, Michael Ference, Jr., Joseph Kaplan, Homer E. Newell, Jr., Hugh Odishaw, W. H. Pickering, A. H. Shapley, Athelstan F. Spilhaus, James A. Van Allen, Fred L. Whipple, J. G. Reid (Secretary).

Working Group on Internal Instrumentation: James A. Van Allen (Chairman), Leroy R. Alldredge, Michael Ference, Jr., Herbert Friedman, William W. Kellogg, Hugh Odishaw, R. W. Porter, O. H. Schmitt, Lyman Spitzer, Jr.

Working Group on Tracking and Computation: W. H. Pickering (Chairman), G. M. Clemence, W. A. Heiskanen, G. P. Kuiper, J. T. Mengel, J. A. O'Keefe, J. E. Steakley, Fred L. Whipple.

Working Group on Satellite Ionospheric Measurements: A. H. Shapley (Chairman), W. Berning, George Grammar, C. Gordon Little, Wolfgang Pfister, J. C. Seddon, Ralph J. Slutz, G. W. Swenson, Jr., O. G. Villard, Jr., A. H. Waynick, H. W. Wells.

An earlier study of the Panel in this area was prepared by R. W. Porter, J. A. Van Allen, H. E. Newell, W. W. Kellogg, and Lyman Spitzer in January 1957. The present proposed program, based on the earlier report, but considerably extending the scope of experimental possibilities, was prepared by W. W. Kellogg in collaboration with the Panel and the Working Group on Internal Instrumentation.

2. SOUNDING ROCKETS

Sounding rockets have provided so much information about the upper atmosphere and its effects on incoming radiation of various kinds that they will continue to be useful in this area. A continuing program using such rockets should be aimed at determining the distribution *in the vertical* of such quantities as:

(i) Atmospheric composition.

(ii) Atmospheric pressure, temperature, and density.

(iii) Winds in the upper atmosphere.

(iv) Atmospheric ionization.

(v) The absorption of electromagnetic radiation penetrating the atmosphere and the intensities of sources of such radiation in the atmospheric layers.

(vi) The absorption of cosmic-ray or solar particles, and the secondary effects of these particles.

(vii) The geomagnetic field (also covered under satellites).

(viii) Detection and location of electric-current systems in the atmosphere.

(ix) Experiments requiring recovery of packages. (See below.)

With a sufficiently intense program, it will be possible to detect latitudinal, diurnal, and seasonal changes of these quantities, and also

the ways in which they are modified during periods of solar activity and magnetic storms.

Until the techniques for the recovery of packages from a satellite have been worked out in more detail and demonstrated, there will be a class of experiments requiring the return of various kinds of samples for which the vertical rocket is required. These may involve:

(i) Film samples: Photographs, spectrographic data, cosmic-ray packets, or data recordings where the quantity of information is too great to telemeter.

(ii) Biological samples.

Experiments which will probably not be suitable for sounding rockets in the future, with the availability of earth satellites of progressively larger payloads, are solar or astrophysical observations, particularly those in which time changes are sought. Clearly, a satellite vehicle is superior for such observations.

3. EARTH SATELLITES

An earth satellite is considered, for these purposes, to be a vehicle which is on an orbit controlled primarily by the earth's gravity. (This means, in effect, something less than 1,000,000 miles from the earth and with insufficient velocity to carry it further.) Even when the technology of space flight has progressed far beyond the ability to put satellites on orbit and vehicles are being directed on heliocentric and interplanetary missions, the earth satellite will surely continue to be a base for fruitful observations.

Fundamentally, a satellite well outside the earth's atmosphere can be used to observe only three kinds of things, namely: photons, particles, and fields.

The photons, since they represent electromagnetic radiation, may range from X-radiation and ultraviolet radiation to radio waves. In general, when dealing with photons coming from remote sources in the sun or beyond, the purpose of a satellite is to observe the wavelengths which do not penetrate the earth's atmosphere. This implies that the radiation of primary interest is at wavelengths below the ozone cutoff in the ultraviolet (about 0.32 microns) and at wavelengths above the ionospheric cutoff in the radio wave region (about 30 m., or 10 Mc.). Most of the radiation in between these limits penetrates the atmosphere and can therefore be observed on the ground or from balloons, except for some important, but limited, regions in the infrared where water vapor, carbon dioxide, and ozone cause absorption.

In addition to observing these highly significant radiations from above, the satellite will be of great value in observing the earth, its changing cloud patterns, its infrared radiation, etc. These are discussed further below.

The particles which can be observed from a satellite are solid meteoroids of various sizes and atomic nuclei with great energy emanating from the sun and beyond (auroral particles and cosmic rays). These are both of great significance to the development of manned space vehicles, since the solid particles constitute a hazard to the vehicle due to their ability to puncture its skin, and the atomic particles may be a hazard to the man inside.

The fields which are measurable from a satellite are the field of gravity and the magnetic field. The first, the field of gravity, is related to the masses and shapes of the earth and moon, and satellite observations promise greatly to improve the precision of our knowledge of these quantities. Magnetic field measurements not only tell about the magnetization of the earth and moon, but also tell about the electric current systems which flow in the vicinity of the earth.

Since a great deal has already been written about the uses of an artificial satellite, the following experiments are presented in outline rather than in detail. First are those which could be done in Vanguard-type satellites, assuming a growth potential in payload to 50 or 75 pounds and a wider choice of orbits than is available under the IGY program. With larger payloads and more advanced techniques there are some more elaborate experiments which could be done, experiments which require stable platforms, large transmission power and information band width, recovery of packages, etc. Finally, there will be manned satellites.

4. LIGHTWEIGHT SATELLITE EXPERIMENTS

(*a*) *Creation of visible objects.*—There are a number of reasons for wishing to have an easily visible satellite. In particular, precision orbit determinations will probably be done optically, and it is clearly desirable to have a satellite which reflects or emits a considerable amount of light. At night a flashing light with a brightness of 10^6 candlepower or more would be just visible at about 1,000-mile range, provided the duration was about 0.1 second or more. An alternative method is the creation of a large reflecting object such as a balloon or erectable corner reflector. Such an object to be seen optically or visually must be near the twilight zone of the earth, so that the observer can see the sunlit reflector against a darkened sky. Under such conditions a 100-square-foot diffuse reflector appears like a first magnitude star at about 200 miles (depending on the angle between the sun and observer), and can still just be seen by the naked eye at about 2,000-mile range. Naturally, with telescopes one can do much better, if one knows ahead of time where to look for the satellite.

With the sort of precision orbit determinations which can be obtained with optical tracking it is possible to do a number of important things, namely:

(i) Determination of air drag at high altitudes, from which atmospheric density can be derived. A possible complication here is the effect of an electrostatic charge on the satellite, and the interactions between this charge, the ions present in the ionosphere, and the earth's magnetic field.

(ii) Geodetic measurements on the size and shape of the earth.

(iii) Lunar mass, for orbits passing near the moon.

(iv) Ion densities, when coupled with certain precision radio techniques.

(*b*) *Total atmospheric thermal and visible radiation measurements.*—A satellite is in an ideal position to measure the total flux of radiation in and out of the top of the atmosphere. The incoming radiation, being primarily from the sun, is largely in the visible part of the spectrum, while the outgoing radiation from the atmosphere is infrared plus the solar radiation which is scattered and reflected upward. These va-

rious fluxes can be sampled by a set of omnidirectional bolometers with coatings which are designed to absorb selectively a certain part of the spectrum. For example, a bolometer which is white in the visible but black in the infrared beyond about 4 or 5 microns, will respond to the thermal radiation from the earth and atmosphere, while one with the reverse spectral characteristics will measure the direct and reflected sunlight. Further, a directional detector of visible radiation pointed toward the sun would, of course, monitor the incoming solar radiation alone. (Such a scheme is included in one of the IGY earth satellites.)

The purpose of this set of measurements is to determine the radiational heat budget of the earth and atmosphere. It is known that an excess of radiational energy is added to the atmosphere in low latitudes and that here is generally a net loss of energy from the polar regions. An understanding of this energy imbalance is basic to an understanding of the general circulation of the atmosphere. Further, such a set of radiation measurements, provided that there were a reasonably fast response, would give a rough indication of the thermal inhomogeneity of the atmosphere and earth. It is likely that a measure of this inhomogeneity would provide an indication of the strength of the cyclonic and anticyclonic circulation. During periods of strong meridional transport of energy by the atmosphere there are rapid migrations north and south of warm and cold air masses, and these could probably be distinguished by their thermal characteristics.

(c) *Mapping the cloud cover.*—On the sunlit side of the earth the contrast in the visible and near infrared between clouds and ground or open water is considerable, and it has been demonstrated dramatically by the use of rocket and balloon photography that the existing weather can be traced by the large area cloud patterns. These cloud patterns can be determined from a satellite by various means. A first approach, in which the scanning of the surface by photocells is performed by the uncontrolled rotation of the satellite, is being developed for the IGY program. In this case the reconstruction of the picture is complicated, however, and the data handling capacity of the telemetering link places an upper limit on the amount of coverage and degree of resolution.

The purpose of such an observation would be to show the cloud patterns over a large area of the earth with a degree of completeness unobtainable with present surface observation networks. For research in meteorology, this will throw new light on the way in which storm systems start and develop, on the broad pattern of flow, on the effects of mountain barriers, etc. If refined to the point where the observations can be made available to meteorologists immediately, it would represent one of the greatest advances ever made in meteorological data gathering, and would surely improve short-term forecasting and hurricane predictions.

(d) *Mapping the night airglow and aurorae.*—The upper atmosphere in the 70 to 150 km. region continuously emits ultraviolet, visible, and infrared radiation. In middle and low latitudes this emission, called the "night airglow," is relatively steady but displays moving patterns. As is well known, the aurorae of the polar regions are tremendously variable. A worldwide survey on the dark side of the earth of this radiation, in the general manner of the cloud cover experiment but with greater sensitivity and less angular resolution, would provide a

map of the activity of the emitting layers. The brightest lines of the upper air emission spectrum are the familiar 5,577 A. and 6,300 A. lines of atomic oxygen, the 5,893 A. doublet of sodium, the OH bands in the ultraviolet and infrared, and the O_2 "atmospheric bands" in the infrared. The last mentioned may be the brightest of all when observed from outside the atmosphere.

The airglow and aurorae present moving complex patterns which must be related to the meteorology of the 70 to 150 km. region. The map of the emission in various wavelengths from the ultraviolet into the infrared would therefore be an invaluable aid in studying the behavior of this important part of the atmosphere. It is significant to note that changes in solar emission are undoubtedly first signaled by changes in the circulation patterns in this same region of the atmosphere, and that these changes probably then work downward to affect the lower atmosphere.

(*e*) *Time fluctuations of solar ultraviolet and X-radiation.*—Solar ultraviolet and X-ray intensities are quite variable, and appear to depend greatly on solar activity. Both X-rays and the ultraviolet are enhanced during a solar flare, in some wavelength regions by an order of magnitude or more. These fluctuations have corresponding effects in the earth's atmosphere. Increased output of hard X-rays, for example, causes a pronounced D layer and an associated interference with radio communications. An increase in the intensity of near ultraviolet solar light could contribute to the marked temperature excursions that have been noted in the ozone layer, and such temperature excursions undoubtedly interact with the surrounding wind patterns.

Since solar ultraviolet light and X-rays have such a pronounced effect on the atmosphere and since their fluctuations are associated with important related effects, it should be very fruitful to monitor these solar wavelengths over a long period of time, say for a year, for the purpose of correlating the ultraviolet and X-ray intensity-time curve with weather, radio propagation, the ionosphere, airglow, winds, etc. Because these solar radiations are absorbed by the atmosphere, the logical place to monitor them is from above the appreciable atmosphere. This could be done in an artificial satellite orbiting entirely above 200 miles altitude. By using suitable windows and gas fillings, photon counters and ionization chambers can be constructed to respond only to radiation within a restricted band. (Such a photon counter, sensitive to Lyman-alpha radiation, is being flown on an early IGY satellite.) With such detectors, various bands from the near ultraviolet down to the hard X-rays could be monitored. Payloads on the order of 50 pounds should be adequate to permit coverage of a number of important wavelength bands in a single installation having indefinite duration of operations.

(*f*) *Distribution of hydrogen in space.*—The hydrogen population of interplanetary and interstellar space has been a subject of much interest and speculation. On the basis of astrophysical observations, the current estimate is about 1,000 atoms per cc. in interplanetary space and about 1 atom per cc. in interstellar space, but the basis for this is uncertain.

The density of hydrogen in space could be determined by observing the hydrogen Lyman-alpha radiation received from space and comparing it with direct solar Lyman-alpha radiation. Hydrogen ions in

space would emit a more or less steady background of Lyman-alpha as they captured electrons. Hydrogen atoms would fluoresce under irradiation by solar Lyman-alpha, and this fluorescence would fluctuate directly with the solar curve. By analyzing the total Lyman-alpha intensity into the steady and solar-dependent components, one could then determine the relative densities of hydrogen ions and atoms. With suitable calibration, the absolute densities could be determined.

The ionization chambers to be used to study solar Lyman-alpha radiation from an IGY satellite could also be used as the detectors for the hydrogen-density experiment.

A valuable refinement of this type of observation would be the measurement of the contour of the Lyman-alpha line with high resolution, possibly using a very high order of reflection from a ruled grating combined with photoelectric scanning Such a technique is capable of a resolution of a few hundredths of an angstrom, which is adequate to reveal the existence of an absorption core in the center of the line. Continuous measurements of this type from the satellite would reveal any temporal variation in the depth of the core of the line, and such measurements could give information about variations in the total neutral hydrogen content between the satellite and the sun, and the temperature of interplanetary hydrogen.

(*g*) *Survey of celestial sources in the far ultraviolet.*—Exploratory measurements made with rockets reveal a very different picture of stellar magnitudes in the far ultraviolet than in the visible. Not only do the stellar emissions show anomalies in the ultraviolet, but intense emission from ionized gas clouds has also been observed.

A satellite equipped with ionization gauges or photon counters with high sensitivity and restricted view would permit a scanning of the sky with better aspect control than is possible with rockets, and would provide a rough map of the ultraviolet "hot spots." Subsequent satellites with better orientation control could then survey these sources in more detail.

(*h*) *Extragalactic light.*—Among the many radiations which strike the top of the earth's atmosphere, the light from sources beyond our own galaxy is one of the most interesting, insofar as it contributes to the profound understanding of the astrophysical nature of the universe. The intensity of this extragalactic radiation is already known to be quite weak in comparison with the light from our own galaxy, and its spectral character is known to be heavily shifted to the red. These facts alone are subject to an immediate cosmological interpretation, viz, the expanding nature of the universe.

The expanding-universe hypothesis can be submitted to more specific test by detailed measurements of the spectrum of extragalactic light and by the distribution of its intensity with respect to galactic latitude.

Such observations are impossible with ground-based or ballon-borne apparatus due to the great overburden of other radiations originating in the earth's upper atmosphere. They might be thought possible with vertically fired rockets which surmount the major emitting layers of the atmosphere, but the intensity is judged to be so weak that the several minutes of a rocket flight provide an inadequate period of time for significant measurement. The long-time duration of a satellite's flight appears to be necessary in order to accumulate significant data.

The proposed apparatus consists of several high-sensitivity, photoelectric telescopes equipped with a variety of spectral filters—all

operating in the visible region of the spectrum. This experiment seems properly classified as an exploratory one. Results are not assured, but if they are obtained they will be of very far-reaching and profound significance.

(*i*) *Cosmic-ray observations.*—The objectives of a cosmic-ray experiment would be (*a*) to make comprehensive observations on the total intensity of the cosmic radiation as a function of latitude, longitude, altitude, and time; (*b*) to investigate the presence of the nuclei of lithium, beryllium, and boron in the primary cosmic-ray beam, and, if present, to measure their intensities; and (*c*) to study, as in (*a*), the intensity of the heavy nuclei separately from the total intensity. Interpretation of the results of (*a*) and of (*c*) should yield a crucial test of the theory of the deflection of charged cosmic-ray particles approaching the earth through the geomagnetic field and should yield new information on the nature and importance of interplanetary magnetic fields. The data of (*b*) should settle one of the leading questions on the astrophysical origin of cosmic rays and on their propagation to the earth. The data from (*a*) and (*c*) should provide a greatly improved understanding of the systematic and sporadic fluctuations of the primary radiation, their astrophysical causes and their consequences on the rate of secondary cosmic-ray phenomena within the atmosphere. A special question is whether the solar sources of cosmic rays yield the same distribution of nuclear species as that of the usual primary beam.

(*j*) *Primary auroral particles.*—The polar aurorae ("northern and southern lights") are caused by the interaction of energetic charged particles with the upper atmosphere. Due to their charges, they are deflected by the earth's magnetic field and are focused on the polar regions. It has been established that the intensity of these streams of auroral particles changes rapidly, apparently due to changes in the sun.

In order to observe these particles, it would be necessary to have a satellite on a high-inclination orbit, since the flux is concentrated toward the poles. By means of simple satellite-borne detectors it will be possible to map out the impact zones of the primary auroral particles on the top of the earth's atmosphere and to observe their changes locally and worldwide with time to a degree not ever likely to be approached by ground observatories. It will be possible rapidly to compare the northern and southern zones of incidence and to study efficiently the ways in which the position and configuration of these zones are influenced by and correlated with geomagnetic field disturbances.

The temporal variations of the incidence of auroral radiations can be comprehensively correlated with observable activity on the sun to an extent not presently conceivable by any other method. In addition, the nature of the primary auroral radiations (e. g., protons, electrons, heavy particles, etc.) can be comprehensively studied, as can their intensities and energy spectra. A comparison of these data with those from ground observatories should be very fruitful in establishing the physical processes which are induced in the earth's atmosphere.

These auroral observations are closely related to observations of the geomagnetic field. Indeed, it would be desirable, for mutual support, to have two satellites aloft simultaneously—one carrying

a magnetometer and the other carrying auroral radiation detectors. Eventually it may be possible to have a single satellite carry both types of apparatus

(k) *Micrometeorites.*—There are various estimates of the number of micrometeorites striking the earth's atmosphere, but few actual measurements. For the IGY it is planned to count such particles in one or two satellites. The limited instrumentation and limited time of operation of the equipment will, however, leave unanswered such questions as: What is the mass spectrum? What is the energy spectrum? What are the fluctuations in total intensity? How are these particles related to visible meteor showers? In a satellite capable of operating over a period of a year, most of these questions could be answered using calibrated microphones, thin diaphragms with photocells to observe punctures, electrostatic analyzers, and the like.

(l) *Magnetic field.*—The earth's magnetic field is mainly due to the magnetization of the earth's mantle and the electric currents flowing in its liquid core, a property which can be quite accurately measured by ground-level surveys or aerial reconnaissance. However, the variations in this main field of external origin, amounting to as much as 7 percent, say, are due to a variety of current systems in the ionosphere and above. (There are current systems induced in the earth also, but these are presumably secondary effects due to the phenomena at great altitudes.) A major source of geomagnetic variations are the direct current systems in the lower part of the E region, which are below the satellite altitudes. However, at much greater distances, perhaps an earth radius or more, there may be another highly variable current system known as the "ring current."

With a satellite-borne magnetometer flying over a monitoring magnetometer on the ground making a simultaneous measurement of the magnetic field, it is possible to determine the horizontal flow of current between the ground and the satellite. The same technique can be used with two satellite magnetometers as they pass over each other. Thus, it is possible to map the electric current systems out through the region of the ring current.

The use of vertical rockets to do this same thing has already been mentioned. In some ways a rocket is superior to a satellite for magnetic measurements, since it can make a vertical profile from the ground up and thereby determine where the electric currents lie. However, these currents are highly variable, and a satellite permits a determination of how they vary in time, how they are related to solar activity, and how they may vary in the horizontal. The ideal approach would be to use rockets and satellites in combination, thereby obtaining a more complete map of the geomagnetic field in three dimensions and in time.

(m) *Ionospheric observations.*—The ionized layers of the ionosphere (D, E, F_1, F_2) generally lie between 80 and 300 or 400 km. They are, therefore, mostly below the level of the satellite. A number of effective methods have been suggested for measuring the total free-electron density between the satellite and the ground, one being a measure of the difference between the angle of incidence of the radio-tracking signal and the optical line-of-sight as the satellite passes over a tracking station. The difference is very small and barely measurable for the radio frequencies best suited for tracking and

telemetering. In order to insure accurate tracking, the USNC-IGY satellites transmit primarily at 108 mc. However, a 40-mc. transmission is also planned for some USNC-IGY satellites, one of the frequencies used in the Soviet satellites, and at this lower frequency more bending and dispersion of the radio waves will occur. The use of some of the techniques of radio astronomy would be appropriate to measure this effect. The addition of two or more frequencies simultaneously would give added meaning to the results. Another observation yielding total electron densities is the rotation of the plane of polarization of the radio wave due to the Faraday effect. Such an observation requires a high gain antenna with a dipole to sense the plane of polarization and a knowledge of satellite orientation

Another class of satellite radio experiments would make use of the satellite as a known source of radiation to measure certain aspects of the fine structure of the ionosphere. It is observed that radio stars fluctuate, and these fluctuations are in part due to ionospheric inhomogeneities of various sorts, some of which are in the E region and some in the F region. A satellite would permit a mapping of these horizontal inhomogeneities (sometimes known as ionospheric lenses), both in the horizontal and in the vertical. Since the satellite may at times be in or below the F region, it will be possible to separate out the various effects of the two regions of inhomogeneity. An especially interesting aspect of the irregularities in ionization of the upper atmosphere is the pattern of the auroral clouds, streamers, draperies, etc., which extend from the E region upward to great heights. These patterns are marked by visual radiation, as is well known, but they are also regions of intense local ionization. The radio signal from a satellite in the auroral zone would be influenced by the auroral ionization, and presumably a study of the fluctuations would tell a great deal about the character and distribution of the ionization in this region.

It should be borne in mind that the gross structure of the ionized layers can be measured from the ground continuously with inospheric recorders, and that the general features of the ionosphere are already quite well understood. Furthermore, it was pointed out above that the fine structure of the ionospheric layers can probably best be obtained by a rocket which penetrates rapidly through the ionosphere, recording successive changes in "radio depth" as it goes. However, it is certain that valuable ionospheric experiments can be made using satellite radio transmissions, and the experiments described above will be possible with any satellite which provides a more or less steady signal with stable frequency and known polarization.

To date, no experiment has been proposed which can measure the free electron distribution above the top of the ionosphere from a single satellite without serious difficulties due to the dominant effects of inhomogeneities in the ionosphere itself and uncertainties in the orbit, which tend to mask any second order effects at the satellite altitude. However, the distribution of free electrons above the ionosphere would be of great significance. The use of two satellites, with a two-frequency transmission link between them, offers an apparently feasible solution. Another possible technique would be the use of a miniaturized sweep frequency ionospheric sounder in the satellite, directing its pulses downward.

(*n*) *Biological experiments.*—Biological experiments should be instituted at the earliest opportunity in the satellite program, since they will be crucial to the eventual attainment of manned space flight. There appear to be two main areas of concern: The biological effects of prolonged exposure to the radiation in space, ranging from cosmic rays to the various solar emissions, and the subtle and complicated effects of prolonged weightlessness.

With regard to the first, a program of exposure of biological samples and live animals to cosmic radiation at high altitude by balloons has been underway for some time, and at the altitudes attainable by balloons (over 100,000 feet) the cosmic radiation is essentially the same as at satellite altitudes. There are other kinds of radiation, such as solar ultraviolet and X-rays, which do not penetrate to balloon altitudes, but these can be reproduced conveniently in a laboratory. Thus, the use of a satellite for the study of radiation effects on biological specimens does not appear too rewarding.

For the study of prolonged weightlessness, on the other hand, there is no known substitute for a vehicle floating freely in space. Biological specimens and live animals have been successfully flown and recovered from high-altitude rockets, having been exposed to a few minutes of weightlessness. The second Soviet satellite carried a dog, thereby lengthening the duration of the period of weightlessness ad mortuum. The USNC–IGY satellite program includes a biological sample (yeast). These first attempts to study weightlessness will have to be greatly expanded in the future.

5. ADVANCED SATELLITE EXPERIMENTS

(*a*) *Selective and directional thermal radiation measurements.*—Since certain constituents of the atmosphere, such as water vapor, ozone, and carbon dioxide, have strong absorption lines in the infrared region of the spectrum, a detector looking downward which is sensitive only in these regions does not "see" the earth's surface. Instead, it detects the radiation emitted upward from the upper levels of the constituent, the radiation from the layers below having been absorbed by the atmosphere. Thus, for example, a detector looking down at around 9.6 microns (in a strong ozone band) would receive the thermal emission from the top of the ozone region at about 10 to 30 km. altitude; a detector looking down at around 6 microns (in a strong water-vapor band) would receive the emission from the top of the troposphere at 8 to 10 km., above which there is relatively little water vapor. A quantitative measurement of the thermal radiation in one of these narrow spectral intervals gives a measure of the temperature (and, to a second order, density) of the emitting layer. A more detailed analysis of the variation of this emission with zenith angle can give the vertical distribution of temperature in the emitting layer. This experiment would require great detector sensitivity and a considerable degree of orientation control, particularly the measure of the "limb darkening" just described. To be most meaningful, the record for an entire satellite circuit should be complete, probably requiring data storage and retransmission over a telemetering station.

The purpose of such a set of measurements would be to map the effective temperature of various layers high in the atmosphere. Some of these layers are inaccessible to conventional sounding balloons, and

even those which are accessible can only be sampled at a few points. As meteorologists have obtained progressively more information about the synoptic conditions in the upper atmosphere (using balloons and occasional rockets to date), they have gained more insight into the behavior of the atmosphere, and weather forecasting ability has gradually improved. However, balloons cannot penetrate the part of the atmosphere which is affected by solar ultraviolet radiation below about 0.3μ (the ozone cutoff). It seems reasonably certain now that short-term changes in solar radiation have an immediate effect on parts of the upper atmosphere, and that these effects propagate slowly downward in a complicated and as yet unexplained way. A synoptic satellite observation of the kind described would probably provide a direct measurement of the immediate effects of a solar disturbance on the thermal structure of the atmosphere. It would, therefore, be a key to the development of a physical basis for long-range weather prediction.

(*b*) *Selective and directional ultraviolet and X-ray measurements.*—As already pointed out, ultraviolet and X-radiation from the sun below about 3,000 A. does not reach the surface, but is absorbed and scattered by various constituents of the upper atmosphere. In some wavelengths this radiation is absorbed in a relatively limited region. Thus, if one scanned the sunlit atmosphere from above, using a number of ultraviolet detectors, one would be able to obtain a vertical profile of several of the constituents. For example, scanning with photon counters sensitive to 1,400–1,100 A. it is possible to survey the vertical distribution of O_2 from the 100-km. level to the top of the ionosphere. At around 2,500 A. one could determine the distribution of O_3 below 100 km. Similar measurements in X-ray wavelengths would monitor density variations in the E and F_1 regions of the ionosphere.

These types of measurements have been proven in rocket experiments. With sufficient payload available, more refined spectroscopic surveys of the earth's atmosphere in the far ultraviolet should be possible using the sun as a light source and measuring its attenuation or studying characteristic resonance lines of the various constituents.

(*c*) *Astronomical spectrograms.*—A spectrograph mounted in an artificial satellite would be able to photograph the sun, planets, and stars completely free from interference by the atmosphere, thus extending the sensitivity far into the ultraviolet end of the spectrum and permitting a much more detailed study of these bodies than is now possible.

Spectrographs to do this job are, in essence, available. Suitable light collectors would have to be designed. A pointing control would be necessary. Such a control could probably be worked out much along the lines of those now used in rockets, and would have a total weight less than thirty pounds. To retrieve the film, it would be necessary to work out techniques for recovery of a capsule from the satellite orbit (or of the satellite itself); however, such techniques have already been proposed and are considered to be feasible within the expected weight limitations.

An alternative to the recovery of film is, of course, the electronic processing and telemetering of these observations. This is discussed further in the next section.

(*d*) *Ultraviolet photographs of the Sun.*—Much of the photochemical and dynamical activity in the sun is associated with the emission of

ultraviolet radiation. Photographs of the sun in various regions of the ultraviolet should permit localization of regions associated with the respective wavelength emissions, and would be an important aid to understanding solar activity.

Suitable filters and UV sensitized films are available for making such photographs. If necessary, pointing controls similar to those already used in rockets could be constructed for directing a camera at the sun. It would probably be desirable (but not necessarily essential) to recover the film after the pictures had been taken; however, as indicated in experiment (*c*), it is believed that suitable techniques could be developed for the recovery operation.

In this type of experiment, the use of photoelectronic recording and telemetering should certainly not be overlooked, however. Such a technique would be a great advantage, for example, if a more or less continuous picture was needed. A variety of approaches can be considered for obtaining photoelectronic pictures of the sun in the ultraviolet or X-ray region. For example, it is entirely possible to measure the distribution of Lyman-alpha over the sun's disc by a photon counter with narrow field of view, sensitive to this line only. By using a simple scanning motion, a crude picture equivalent to a television scan of about 20 lines resolution is even possible in a rocket experiment, and the longer time available in satellite measurements would permit such scans to be made with more resolution and in other interesting wavelengths such as the helium resonance lines at 584 and 304 A, the MgX line at 625 A., and in various X-ray wavelengths.

(*e*) *Planetary spectrograms.*—A variation of experiment (*b*) would measure the spectra of the various planets in the ultraviolet and infrared. All of the central planets have visible atmospheres, but the composition of these atmospheres is difficult to observe spectrographically from the ground due to the presence of the same or similar gases (in differing proportions) in our own atmosphere. For example, the solar ultraviolet radiation reflected from these planets is completely absorbed by our atmospheric ozone, and large segments of the infrared radiation which is emitted are absorbed by water vapor, carbon dioxide, and ozone, plus other trace constituents such as methane, nitric oxide, etc. A satellite would have a clear view of these planets.

The radiation from them is very weak, however, and would require quite accurate positioning of the spectrograph in order to provide long exposures with limited angular fields (in order to minimize the cosmic and stellar background). Moreover, it would probably be most desirable to recover the spectra in the form of exposed plates, though it is possible to telemeter the information to the ground.

(*f*) *An experimental test of the general theory of relativity.*—One of the predictions of the general theory of relativity is that the fundamental time scale of atomic phenomena (e. g., frequency of emitted spectral lines) is influenced by the gravitational potential in which the emitting system is located. This prediction has received thus far only a very few observational verifications, and even these remain in a somewhat controversial state. It is conceivable to mount a so-called caesium or thalium "clock" in a satellite and a similar one at a ground station and intercompare the rates of these two clocks over an extended period of time. By the general relativistic theory, it is expected that there would be a systematic difference in the rate of running of these two

"atomic clocks" due to the known difference of gravitational potential to which they are subjected.

The effect is a small one, and it appears that accumulated observation over a period of the order of a month may be required to surmount reasonable experimental errors in location of the position of the satellite and in ionospheric conditions. (Both effects, of course, influence the transit time of the transmitted intercomparison signal from the satellite to the ground station.)

A proposal is known to be currently under consideration for a similar intercomparison between clocks, one of which is located on a mountain and the other in a neighboring valley. However, if the technical problems can be adequately solved, it may be desirable to utilize a satellite for a more sensitive test of this very profound theoretical hypothesis under different conditions.

(*g*) *Solar (cosmic) radio noise in the HF and LF spectrum.*—High-frequency radio waves below about 5 mc. cannot penetrate the ionosphere, and even radio waves at 20 mc. are sometimes totally absorbed. Thus, it is not possible to observe from the ground the lower frequency end of the radio noise which comes from the sun and beyond.

A satellite would, of course, not suffer from ionospheric absorption, but the signal levels in this region are low and the antennas required to obtain much gain have to be large. However, by using long wires, or large erectable reflectors or lenses to concentrate the signals and to obtain directionality measurements could be made on HF signals below the ionospheric cutoff.

(*h*) *Collection of micrometeoritic samples.*—If the techniques can be worked out for recovery of the satellite or of small capsules from the satellite, a long-period collection of micrometeorite particles could be obtained. These samples could be collected in containers filled with something like silicone grease, which could be opened while the satellite is on orbit and then closed just before the recovery operation was begun.

The recovery of a representative sample of meteoric material would be of value for a number of reasons: It would throw light on the relative abundance of elements in the solar system; it would help to resolve the questions concerning the scattering effect of this dust, observed as the zodiacal light; it would supplement the previously mentioned satellite observations of meteors by their impact effects, etc.

(*i*) *Manned satellites.*—In section 8, manned space flight is discussed briefly, and it is pointed out that man will inevitably venture into outer space sooner or later. Whether the presence of a man in the vehicle will contribute to our knowledge of the universe is beside the point. Such an achievement should, perhaps, be considered as an end in itself—the ultimate biological experiment.

6. LUNAR INVESTIGATIONS

One of the major justifications for building and launching a rocket to the moon is the knowledge which would be obtained about our nearest neighbor in space. The emphasis of the long-range program described here is on an orderly progression of technical development and scientific research into problems of outer space. In this context, the investigation of the moon is but a step to the investigation of the planets.

There are several potentially fruitful experiments and observations on the moon, some of which could be done by impacting the moon directly (the impact velocity would be about 9,000 foot-seconds for a vehicle taking 2 to 3 days for the trip), some of which could be done by a circumlunar orbit (which would be a special kind of satellite), and some of which would require the lowering of instruments to the surface. Ultimately there will be manned vehicles capable of landing on the moon.

The early experiments which should take priority are, in general, those which give information about the moon *as a whole*, rather than about the particular point of impact. These will reveal the most about the processes by which it was formed, its past history, and so forth, and will be most useful in planning for subsequent experiments. The three quantities to be measured which pertain to the moon as a whole are the lunar gravity or mass, its magnetic field, and its atmosphere. Of these, probably the last is the only one which requires landing on the moon. A further experiment, described more fully below, is the determination of the internal structure of the moon by seismic prospecting techniques—this will certainly require the landing of an instrumented package.

(*a*) *Measurement of lunar mass and gravity.*—Present estimates of the moon's mass, based primarily on observations of the motions of asteroids and of the motions of the earth's polar axis, have a possible error of about 0.3 percent. Such a great uncertainty would affect any calculation of the trajectory of a moon rocket, since calculations must take into account the moon's mass. It is therefore desirable that one of the early moon experiments be devoted to a more precise measurement of this quantity.

There are two possible ways of doing this. The best way is to track the rocket as it approaches the moon, and to deduce from the path which the rocket takes, and from its instant of arrival, the force of the moon's pull at each point. This is entirely practical in principle, but it requires considerable accuracy in the tracking. The accuracy requirements almost certainly could not be met by an electronic tracking system on the earth. A radar altimeter and doppler drift measurement from the lunar vehicle itself might provide sufficient accuracy for such a determination. The use of ballistic cameras which could position a large diffuse reflector or a flashing light on the vehicle against the star background is also a promising possibility for accurately determining the motion of a vehicle relative to the moon.

An alternative method would measure the lunar gravity from the surface of the moon directly, after the rocket had landed. This kind of measurement is relatively simple, and can be performed by measuring the displacement of a known mass suspended from a carefully calibrated spring, by measuring the time-of-fall of a body in a known distance, by measuring the period of swing of a pendulum of known length, etc. Any one of these techniques is capable of measuring the gravity of the moon with an error considerably less than one part in a thousand.

A measurement of the lunar gravity at some point on the surface is not sufficient to determine the lunar mass, however. The other parameter is the square of the distance between the measuring point and the moon's center. The average radius of the moon is about 1,740

km. Some of the mountains of the moon have been determined to be more than 1.3 km. high. There are escarpments over a kilometer high separating plateaus from low lying plains or maria, and the crater bottoms are at a different level from the surrounding land. In fact, the variations between various parts of the moon's surface, since the so-called "continental" or "sea" areas are at different heights above the mean level, makes a determination of the size and shape of the moon somewhat uncertain. According to Baldwin, the lunar bulge is 2200 m. (in the direction of the earth), and the uncertainty in this quantity is about $\pm$ 200 m. This alone corresponds to a possible error in height above the moon's center of 1/10,000, and a corresponding error in the lunar mass determination of 0.02 percent. It would appear, therefore, that this may be the limiting factor in determining the lunar mass from an observation of lunar gravity on the moon's surface, but it would still reduce the present uncertainty by an order of magnitude.

(*b*) *Direct measurement of the lunar magnetic field.*—At present there is apparently no evidence at all that the moon has a magnetic field It must have one, however, since it could hardly have existed for so long in close proximity to the earth without experiencing some effect of the geomagnetic field. Furthermore, the lunar magnetic field would depend on the method of formation of the moon and on the magnetic field in which it existed during its formation.

If we consider that an approximate lower bound to the lunar magnetic field is the strength of the earth's magnetic field at a distance of 386,000 km., then we would be faced with measuring a field of about 0.14 gammas. (The magnetic field at the surface of the earth is about 0.5 gauss, or 50,000 gammas.) Familiar techniques exist for measuring magnetic fields down to a few gammas, but this remnant of the earth's field may, by itself, be too small to measure. Thus, the first such magnetic field measurement should be considered as exploratory, with as much sensitivity as possible.

It may be that the moon's field is much stronger than this, due, perhaps, to internal circulations while it was cooling, or it may be that the moon's magnetic field does not align itself with the extension of the earth's field. If either of these possibilities is true, it would be of considerable theoretical interest, since it might reveal something about the way in which the moon was formed and about the history of the earth-moon system.

Another likely cause of a lunar magnetic field larger than the one just calculated would be the retention of the larger magnetic field in which the moon was embedded at the time of solidification. It has been held that the moon was closer to the earth when it solidified, and so may have been in a stronger field at this time.

(*c*) *Mass spectrographic measurements of the lunar atmosphere.*—It is customary to think of the moon as having no atmosphere at all Astronomical observations have given no sure indication of a lunar atmosphere. Theoretical calculations on the persistence of any remnant of an atmosphere show that even the heavier gases, such as krypton, xenon, and perhaps CO_2, would slowly escape from the hot sunlit side of the moon.

Nevertheless, there is a possibility that enough gas is trapped in the crust of the moon so that there is a steady leakage of this gas. The heavier gases would stay on the surface for a while, so there would

be a very tenuous but constantly replenished atmosphere. A measurement of the constituents of this atmosphere would reveal information about the rate at which these gases were being released by the crust. This would be of considerable help in understanding the constitution of the crust and the way in which the moon was formed.

It is possible to design a lightweight mass spectrograph which could give an indication of both the atmosphere density and the atomic mass distribution of the lunar atmosphere—or at least an estimate of an upper bound of the amount of each gas present. The University of Michigan has proposed a design for such a gas analyzer, working on the principle of an "omegatron," which could possibly be used in a satellite vehicle and which would operate down to pressures of the order of 10^{-10} mm.Hg. If it could function in a satellite, then it should be able to function on the moon. There does not seem to be any sure way at this time of estimating whether this lower limit in pressure will be enough to detect the trace of a lunar atmosphere, but the experiment certainly warrants a try (perhaps preceded by the observation of pressure described in (d)).

(*d*) *Pressure and density of the lunar atmosphere.*—A measurement of the pressure or density of the lunar atmosphere alone would not be useful as a measure of the individual constituents, as suggested in the previous section. Its only advantage would be in the fact that a pressure measurement is simpler, in principle, than a mass spectrographic measurement. If weight or complexity were a problem, then it might be desirable to make a pressure measurement first. Having established the existence or nonexistence of a measurable atmosphere, the decision to operate a mass spectrograph could be made on a firmer basis.

(*e*) *Seismic and microseismic observations of the lunar crust.*—There are probably two natural sources of motion in the moon's crust: those caused by shifting, sliding, or folding of the crust; those caused by the impact of meteoroids.

In order for the first to occur, the middle of the moon would have to be plastic or molten, as in the case of the earth, since it is hard to imagine much shifting of the moon's crust if the moon were a rigid sphere. Occasionally there might be a landslide due to small-scale fracturing of a cliff subjected to the large monthly temperature variations, but a landslide would probably not register as a "moonquake." It is an open question as to whether the moon has a molten interior. In the geologic past there seems to have been volcanic activity, and the maria appear to have been laid down as a covering of molten material. However, since man has been observing the moon there has been no clear case of an active volcano on the moon, and so it may be completely solidified by now. Listening for moonquakes would be one way to find the answer to this riddle.

There is, however, no doubt about the fact that meteoroids are continually impacting on the moon. Most of the particles from interplanetary space are very small, with diameters of less than a millimeter. These would have almost no effect on the moon's surface during our period of observation and would not cause any measurable microseisms. However, there is a definite possibility that several large particles might hit somewhere on the moon during the period of observation. Depending on their energies and their distances from the instrument, the impacts would be detected as waves in the crust,

just as the impulse from explosions on the earth's surface is picked up hundreds of miles away. In the case of the moon there does not seem to be any way of determining how far away a meteoroid hit, but it might be possible to get some useful information from the character of the pulse.

If an explosion (or explosions) could be created at a known time and at a place some distance from the recorder, then one could make full use of the powerful techniques which have been developed for seismic prospecting. For studies of the lunar subsurface and core, this would certainly be preferable to depending on meteor impacts. In order to use seismic prospecting techniques, one must know the distance between the explosion and the recorder, and the recorder must be able to measure the time of travel, and the character, of the shock wave. Actually, after traveling a short distance in the lunar crust the original shock wave would be broken up into a number of waves with different group velocities and modes of propagation, and the analysis would depend to a large extent on being able to sort out the various components of the wave. This would mean that the wave would have to be recorded with considerable time resolution, and the record would then be transmitted to the earth by a playback mechanism. This would allow one to expand the time scale of the record in order to accommodate the band width of the telemetering link.

The source of the shock used in the seismic experiment, which must be at some distance from the detecting instrument, could be an HE or atomic explosion, or, possibly, the impacting of another part of the vehicle system. For example, if a last stage similar to the Vanguard second stage were used to start the instrumental section on its way, weighing about 800 pounds empty, it would release an amount of energy on impact with the moon (at 9,000 foot-seconds) equivalent to nearly the same number of pounds of TNT. Naturally, the instrument package would have to precede it and land before the impact of the booster occurred, but this would require only a small extra push to the package early in the flight.

A more elaborate experiment can be conceived, in which grenades could be ejected from the moon rocket, could travel a known distance, and then explode on hitting the ground. This would give a pulse of known energy at a known distance from the seismograph. If this experiment were considered crucial enough, it could probably be performed, but the weight of the auxiliary projectiles, the accuracy with which they could be aimed, the effects of rough terrain, and other problems make such an undertaking seem rather difficult.

(*f*) *Observations at the point of impact.*—As mentioned earlier, the most valuable experiments, at least in the initial stages of lunar exploration, are those which deal with the moon as a whole. However, it is clear that there are a number of things concerning the surface on which the package landed which would be of great interest. Among the important properties which would lend themselves to measurements are:

(i) Temperatures of the surface and subsurface.
(ii) Surface hardness.
(iii) Chemical composition of the surface material.

A Soviet suggestion for the use of mobile instrument carriers equipped with television links to the earth (called "tankette labora-

tories") is an interesting way of extending such local observations over a wider area.

7. PLANETARY AND INTERPLANETARY INVESTIGATIONS

The requirements for landing an instrument package gently onto the surface of the moon are roughly equivalent in difficulty to those for placing the same weight of instruments on a collision course with either Mars or Venus. The detailed problems to be solved are different, particularly with respect to guidance, but the propulsion requirements may actually be considerably less for the interplanetary flight. It should be noted that the velocity necessary to escape from the earth-moon system is less than 0.01 percent greater than the initial velocity required to just reach the moon.

The achievement of a heliocentric orbit is in many respects easier than an interplanetary (i. e. planet-to-planet) trajectory, since the propulsion requirements are about the same while the guidance accuracy required would probably be less, depending on what is expected of the orbit. For this reason, it is not unreasonable to treat interplanetary and heliocentric flights together, even though the scientific objectives may be quite different.

One of the major problems in unmanned interplanetary flight will be that of communications and tracking. For example, at the distance of Mars at closest approach (about 50,000,000 miles on the average), it would require an astronomical telescope with a 20-inch aperture to see a one kilometer diameter sphere with an albedo of one (a white surface). This suggests that very large inflatable balloons or corner reflectors will have to be used if the space vehicle is to be tracked optically, or it will have to carry a bright source of light on it. Tracking by radar is not out of the question, though powerful transponders would be required to allow it to be reached at such a range.

Communication over these great distances will obviously require a great deal of transmitted power. All other things being equal, the power required increases with the square of the range of the communications link. For example, it is claimed that an advanced narrow band width (an effective predetection noise band width of 10 cycles per second) telemetering system called the microlock system can now be designed to reach 3,000 miles with only 1 milliwatt of transmitted power. At the mean distance of Mars at closest approach the power required for such a system would be about 200 kw. There are undoubtedly other schemes which are better suited for this, but the problem certainly requires attention.

Some of the scientific objectives of interplanetary flight, objectives which can only be attained by such an effort, are listed below. An attempt has been made to name the simpler experiments first, and it appears that these simpler ones would in every case yield information required for the planning of the succeeding flights.

(a) *Determination of the astronomical unit.*—The basic unit of length used in astronomy is the semimajor axis of the earth's orbit about the sun (the astronomical unit or a. u.), now estimated to be 92,900,000 miles or 149,600,000 km. and known only to three or, at most, four significant figures. It is taken as the basic unit because the diameter of the earth's orbit is the longest baseline which terrestrial astronomers can ever achieve. The parsec, a derived unit of length which is

commonly used to measure stellar distances, is the distance at which the astronomical unit subtends one second of arc. In order to relate the a. u. to our usual yardsticks, it is necessary to triangulate from the earth on interplanetary objects whose orbits can be observed and timed. The closest objects of this kind are the asteroids, but the closest asteroids are several million miles away, and so triangulation from a baseline on the earth on such an object cannot be done with great accuracy (as evinced by the uncertainties in the above quotation of the a. u.).

The situation would be greatly improved if astronomers were provided with an "artificial asteroid," one which passed relatively close to the earth occasionally and which could be observed as it circles around the sun. Ways of making it observable will require further thought, as will the corrections which may have to be applied for solar radiation pressure, meteoric and coronal drag, the perturbations of the earth and planets, etc. By the time this experiment is achieved there will probably be enough information available on interplanetary conditions to permit such corrections to be made quite precisely.

An improved value of the a. u. would reflect itself in improved precision in other fundamental constants. For example, the constant of gravitation expressed in terms of the a. u., the solar mass, and the mean solar day, is known from astronomical observations to nine significant figures; the gravitational constant expressed in c. g. s. units is known from laboratory measurements to only four significant figures. It is the low accuracy in the conversion factors between the two sets of units, especially the unit of length (a. u. to c. g. s.), which prevents a conversion of the more precise value of this fundamental constant to the c. g. s. system.

(*b*) *Determination of planetary masses.*—Having established the distances between objects in the solar system more accurately, the next objective in astronautics would be the determination of the masses of these objects. It is necessary to know the mass of a planet in order to determine its effects on the path of a nearby space vehicle, so planetary masses will be an essential input in calculating interplanetary trajectories accurately.

It is just this relationship between planetary masses and trajectories which forms a useful basis for a mass determination. Space vehicles dispatched on paths close to the various planets would be accurately tracked (perhaps with auxiliary position sensors in the vehicles themselves such as star trackers and radars). From a precise trajectory, the planetary mass would be deduced.

(*c*) *Entry into planetary atmospheres.*—As noted above in connection with advanced satellite experiments, section 5 (d), it will be possible to learn a good deal about the planets and their atmospheres from satellite observing stations. However, a logical prelude to actually landing on a planet (though probably not a necessity for Mars or Venus) would be the observation of the behavior of an instrumented "reentry body" as it plunged into the planet's atmosphere. From a knowledge of its approach trajectory and a time history of altitude, deceleration, and vehicle surface heating, the atmospheric data necessary to design subsequent entry vehicles could probably be determined.

Of course, the planets differ tremendously. Present estimates indicate that the penetration of the atmospheres of Mars or Venus, given a slanting approach, would be even easier than for a satellite returning to Earth. The atmosphere of Mercury is essentially nonexistent. It is for the larger outer planets that such atmospheric entry bodies or probes would be most useful. This is discussed further in the next section.

(*d*) *Landing on the planets.*—Clearly, each planet is unique in its characteristics, and so the objectives and techniques for a landing vehicle on each planet would be different. Mercury, small and sun scorched, poses many of the same problems as our moon. Venus and Mars, the most intriguing planets as well as the closest, will undoubtedly merit attention first, and the problems associated with placing instruments on their surfaces are so similar to placing instruments on our earth's surface that development of landing schemes and experiments should be fairly straightforward, once the guidance and propulsion problems have been overcome. The large outer planets are entirely different from the inner planets, and there may be no such thing as "landing" on their inner cores, which very possibly are nowhere solid but may consist of a liquid center merging with a deep gaseous envelope. One might, instead, design a vehicle which would enter the atmosphere of such a planet and then settle to a certain density level where it would float, like an inextensible balloon. As for Pluto, we can now only guess at what its atmosphere and surface are like.

Restricting the discussion to Venus and Mars, the significance of obtaining observations on the surfaces of these two planets is too obvious to require emphasis. Moreover, the number of things which one would wish to find out about these sister planets is overwhelming. The most compelling question is, undoubtedly: What forms of life, if any, do they have?

For the purpose of paving the way for subsequent landings on these two planets by manned spaceships, the following are probably the most important features to be determined:

(i) Atmospheric density and composition near the surface.

(ii) The range of atmospheric temperatures and winds near the surface.

(iii) Gross terrain features, such as mountains, valleys, snowfields, and, at least in the case of Venus, possible rivers and seas. It must be remembered that the surface of Venus is unobservable in the visible or infrared due to the continuous cloud deck, so one must both land to explore its surface, and fly over it at relatively low altitude to map it by radar. Mars could probably be roughly mapped by serial reconnaissance without having to penetrate its atmosphere, but it might be impossible to identify some features without a closer look.

(iv) Surface composition. One would expect the surfaces of these planets to be infinitely varied, as is the surface of the Earth. Still, one would learn a great deal about the conditions to be encountered on landing if one had previous knowledge of the chemical composition of some representative soils, their hardness and depth, their moisture content, etc.

8. MANNED SPACE FLIGHT

Although it is impossible to predict how quickly man himself will follow his exploring instruments into outer space, the inevitable culmination of his efforts will be manned space flight and his landing on the nearer planets. It is clear that he can develop the ability to do this, and it is hard to conceive of mankind stopping short when such a tempting goal is within reach.

The attainment of manned space flight, however, cannot now be very clearly justified on purely rational grounds. It is possible, at least in principle, to design equipment which will do all the sensing needed to explore space and the planets. Mobile vehicles could be designed to land and crawl across the face of each of these distant worlds, measuring, touching, looking, listening, and reporting back to earth all the impressions gained. They could be remotely controlled, and so could act like hands, eyes, and ears for the operator on earth. Moreover, such robots could be abandoned without a qualm when they ran out of fuel or broke down.

Though all this could be done in principle, there may be a point at which the complexity of the machine to do the job becomes intolerable, and a man is found to be more efficient, more reliable, and, above all, more resourceful when unexpected obstacles arise. It is, in a sense, an article of faith that man will indeed be required to do the job of cosmic exploration personally and, furthermore, that he will want to do the job himself, whether required to or not.

With man's first venture into outer space a new program of research and exploration will begin. The program described above will, therefore, be the prelude to the drama to follow.

Mr. McCormack. According to the understanding, we are very glad to have with us another distinguished gentleman. We are glad to have you with us.

Dr. William H. Pickering, director of the Jet Propulsion Laboratory of the California Institute of Technology.

Dr. Pickering?

Dr. Pickering. Thank you, Mr. Chairman.

Mr. McCormack. We have the biography of both of you gentlemen. And without objection we will see that the staff puts that in the record preceding your testimony.

Dr. Pickering. Thank you.

STATEMENT OF DR. W. H. PICKERING,[21] DIRECTOR, JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIF.

Dr. Pickering. Mr. Chairman, in recent months it has become obvious to all of us that the scientific and technological leadership of our country has been challenged by the dynamic growth of science and technology in the U. S. S. R.

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[21] Pickering, Prof. W(illiam) H(ayward), California Institute of Technology, Pasadena 5, Calif. Electrical engineering. Wellington, N. Z., Dec. 24, 10, nat. 41; m. 32; c. 2. B. S., Calif. Inst. Tech., 32, M. S., 33, Coffin fellow, 33–35, Ph. D. (physics), 36. Asst. and teaching fellow physics, Calif. Inst. Tech, 32–36, instr, 36–40, asst. prof. elec. eng, 40–45, assoc. prof. 45–47, prof, 47 —, div. chief Jet Propulsion Lab, 52–54, Director, 54– Lecturer, Southern California, 38. Civilian with Research Develop. Board; A. F, U. S. N., U. S. A, 44. Inst. Elec. Eng; sr. mem. inst. Radio Eng. Cosmic rays; telemetering from balloons and rockets; microwave propagation; development of cosmic ray radio sonde; missile guidance problems.

The sputniks were a remarkable achievement, but these are only the last in a long list of triumphs in both military and civilian technology that the U. S. S. R. has shown to the world in the last decade.

Viewed against the background of a nation which was only recently one of the most backward of the major powers, this is even more remarkable. It therefore behooves us to either accept second-class status or demonstrate to all the worldt hat we are capable of an even more dynamic development.

The area of space science is only a part of the complete scientific picture, and although it has had a most dramatic impac ton the people of the world, it is essential that we do not become so obsessed with this activity that we neglect other areas of scientific endeavor.

Like the atomic energy field, space technology will reach into many parts of science and will contribute technical advances in quite unexpected areas. Therefore, support of space science will nurture much other scientific achievement, but it will not be a substitute for a broad program of basic scientific support.

The really important future scientific breakthroughs may come in completely unexpected fields, and only if basic research in these fields is adequately supported can these achievements become American and not Russian achievements.

Space technology is obviously of interest both to the scientists and military men. In my opinion, the scientific interest should come first. Only in this way can we be assured of a technically sound and complete exploration of the potentials of space.

I will expect that military applications would follow quickly upon the completion of scientific objectives. This pattern has been followed for many years. The experience of World War II demonstrated how scientific work could be quickly transferred from the laboratory to the battlefield. Since World War II the support which the military departments have given to basic scientific studies in the universities and elsewhere has been an indication of the appreciation of the military for the contribution of basic scientific work to military technology.

The exploration of space will follow a pattern which has been exemplified by the exploration of the upper atmosphere. Instruments are now being used to explore the properties of the upper atmosphere at altitudes far beyond those attained by manned vehicles.

I might note that since World War II rockets of various sorts have been used for this purpose and a continuing program of upper atmosphere exploration has been carried on in this country and elsewhere. This has led to a tremendous amount of scientific information about the properties of the upper atmosphere up to perhaps a hundred miles above the surface of the earth.

Similar types of instruments will be used to extend our knowledge far beyond the earth out into space and eventually to the moon and to the planets. Manned vehicles will be expected to come along later, after our experience with instrumented vehicles has shown the problems to be encountered and solved before man can safely venture out into space.

In conducting this instrumented exploration many new and unexpected phenomena may be encountered. It is only when we have a thorough understanding of these phenomena that we can properly utilize space for military or commercial applications or for manned vehicles.

The exploration of space even with instrumented vehicles is very costly. It is therefore essential that a well-planned national program be established. Such a program must be coordinated with the scientific community; it must be imaginative but not extreme; it must be actively pursued in order to maintain our national stature; and it must be funded on a long-term basis, because of the long lead time in most of the objects with which this would be dealing.

Likewise the program must receive active support from the military services because of the guided-missile technology which obviously must be used to initiate the work.

In view of the magnitude of the effort which is estimated to become comparable with the AEC expenditures, it appears that a national space agency is required. The proposal contained in the President's message of April 2 appears to embody most of these objectives.

This proposal appears to build a new NASA on a nucleus of the present NACA. However, it is clear that the charter of the new agency differs in kind as well as in magnitude from that of the NACA. As stated by Dr. H. Dryden to your committee on April 16—

> Over the years, NACA has interpreted its charter to mean that its primary task was to provide the aircraft industry and the military services with information and technical data of a fundamental nature that would assist them in constantly improving military and civilian aircraft and missiles.

The proposed new agency is charged with, as stated in section 6A:

> (1) Develop a comprehensive program of research in the aeronautical and space sciences;
>
> (2) Plan, direct, and conduct scientific studies and investigations of the problems of manned or unmanned flight within or outside the earth's atmosphere with a view to their practical solution;
>
> (3) Develop, test, launch, and operate aeronautical and space vehicles,
>
> (4) Arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and provide as appropriate for dissemination of data collected; and
>
> (5) Submit to the President for transmittal to the Congress an annual report of operations and accomplishments.

I am particularly interested in items (3) and (4) which I believe represent a significantly different approach than the present NACA approach to aeronautical problems. Here the new agency is given responsibility for a complete space-vehicle program including the scientific mission.

Thus the present NACA will find that the new agency becomes one of its best customers, and only in this sense is the NACA really a nucleus for the NASA.

The present NACA has proved to be of tremendous value to the whole aircraft industry—both civilian and military, and it appears to me that it should continue to act in this capacity not only for the aircraft industry but also for the new space-vehicle programs of both civilian and military groups.

The NASA would then conduct its space experiments with a new administrative organization which would probably have much of its work done by contract, while the NACA part of the organization would continue to provide essential basic engineering and scientific information.

I believe that if the new Agency can be established with the systems responsibility indicated by section 6A, paragraphs (3) and (4), that

this will indeed be the proper approach to solving the civilian space problems of the Nation.

Those of us who have been associated with the rocket and guided missile art for the past decade are well aware of the necessity for proper systems integration in programs of this complexity. Perhaps some day a space vehicle will become just another truck to carry a payload out into space or to some distant planet, but that day is a long way off and for now we must appreciate the fact that all space experiments will be conducted as research-type activities in which the success of the mission will depend largely upon the care with which the complete system for the experiment has been designed.

In conclusion, I can only stress my belief that it is urgent for the national space program to be established on a firm, continuing basis. We are already behind Russia in this area and unless we move energetically into a program which is on a sound scientific basis, we will continue to be second to the Russians.

The CHAIRMAN. In connection with any questions asked by the members of the committee, gentlemen, you may interchange in making your answers.

You have both read the bill, have you not?

Dr. DUBRIDGE. Yes, sir.

Dr. PICKERING. Yes, sir.

The CHAIRMAN. Do you think the bill contains the language which would emphasize the civilian side more strongly?

Dr. DUBRIDGE. Yes.

The CHAIRMAN. We all recognize, of course, the necessity for this and its military applications.

Dr. DUBRIDGE. Yes.

I think we both stress the fact that there are important military applications. I am assuming the Defense Department will continue in the future under whatever organization is created to continue the military space research necessary for purely military objectives.

But there are many objectives in space research that do not have obvious or direct military application and importance. Therefore, an additional agency is needed for that.

The CHAIRMAN. Have you any particular views as to the kind of organization that should be set up, which might be different from the form or nature of an agency as outlined in the bill?

Dr. DUBRIDGE. I think that, in many respects, the bill creates a very good pattern. My only reservation in regard to the bill is that it creates the impression—though I think, if you examine it, as Dr. Pickering has pointed out, you will find that this impression was not accurate—the bill creates the impression that the new agency is only a slightly enlarged NACA.

But, as a matter of fact, it differs from NACA and, in real content, it is really a new agency of which NACA will now become a part and only one part. And I think that this illusion, that the bill expands NACA without doing anything else, has created some misunderstanding, and I think some of the discussion this morning was based upon this misunderstanding that the NASA, as proposed in this bill, is only a slight elaboration of NACA.

It is different from NACA in at least two respects. First, this becomes not just a research agency, but a widespread—well, I do not like to use the term "operating" because the term "operation"

has some misunderstanding, as we discovered. But it has a widespread authority in directing and stimulating and carrying out programs of space exploration whereas the NACA is largely a laboratory research agency.

And, secondly, the relation between the Director and the Board in the new bill is essentially different from the relation between the Director and Board under present NACA in this respect: Under the NACA, established many years ago, the Board is the responsible agency. It is kind of like the board of directors of a corporation. It is the responsible, policymaking agency.

It selects the Director and then delegates to the Director the responsibility for selecting the staff and carrying out the program under the policies established by the Board. But the NASA, as I understand it, has the Director of the Agency, who is the responsible person, responsible directly to the President, and the Board that is created is more of an advisory commission or an advisory board advising the Director.

In other words, the NACA follows one pattern; the NASA follows a pattern more like that of the National Science Foundation. And the more recent tendency in Government has been to follow the National Science Foundation plan rather than the NACA plan.

And this NASA is more like the National Science Foundation scheme; namely, a director appointed by and responsible to the President, and a board whose function is really advisory.

The Director is morally bound, I am sure, to follow the policies which the Board recommends and formulates and yet, in principle, the Director is responsible to the President directly, not through the Board to the President.

Now, this is an important distinction. And I am not saying at the moment which of these two philosophies is correct. But they are different.

Therefore, I think it is a mistake to assume that NASA is only an expansion of NACA. I am glad that this is the case, because I think the job to be done by NASA is, in substance and in content and in kind, different from the job that NACA has had.

I would like to think of this as a brandnew organization, created to do a brandnew job, a very extensive and a very important job, of which the old NACA job is just one part.

The CHAIRMAN. Dr. Pickering, you referred in your statement to five of the basic conditions that the new Agency will be charged with and have jurisdiction over. They were to develop, test, launch, and operate astronautical and space vehicles? Isn't that pretty broad language?

Dr. PICKERING. Yes.

The CHAIRMAN. Does that carry the power for this Agency to make contracts with others in the exploration and in the operational angle?

Dr. PICKERING. That is right. In order to carry out this assignment, it must have all of these other powers. And, as far as I am concerned, this centralization of the powers in this Agency, I believe, is correct.

The CHAIRMAN. Do you think the two agencies of Government should have the same power as Dr. Furnas indicated?

Dr. PICKERING. I believe that the NASA should have this power, because I think, largely because the problems of carrying out this kind of a program involve the utilization of a very large test equipment, if you want to say it that way. In other words, very large test missiles of various sorts. And it involves various expensive test programs. Therefore, it only makes sense if you have a real, coordinated program under one agency directing it.

The CHAIRMAN. From that angle, there would be no necessity of creating another agency if one agency of government already had the jurisdiction?

Dr. PICKERING. No. I say NASA is that agency. I do not believe any agency now has the authority to do this.

The CHAIRMAN. Well, Dr. Furnas seemed to indicate——

Dr. PICKERING. We disagree.

The CHAIRMAN. That he favored, also, the National Science Foundation through its contract powers. You would not agree with that, would you? Well, I do not want you to pass on somebody else's testimony.

What are your views on that?

Dr. DUBRIDGE. If I may put in one word; the first part of the questioning this morning revolved around the misunderstanding of what you mean by "operating." Now, if I may explain what I mean by "operating," the National Science Foundation is not an operating agency. It does not operate its own laboratories. It contracts for all of these operations. The Atomic Energy Commission is not an operating agency. It contracts for all of its activities, for its research, for its development, for its manufacturing, and everything else.

The CHAIRMAN. But, through the contracts, it is an operating agency?

Dr. DUBRIDGE. It controls, but it does not operate.

The CHAIRMAN. I know, but——

Dr. DUBRIDGE. You see, there is the point of distinction between what you mean by "operating" and "not operating."

Mr. MCDONOUGH. But it does specify?

Dr. DUBRIDGE. The NACA is an operating agency. It operates its own laboratories. It does not contract for them at all. They are Government laboratories; they are Government controlled and paid for; and civil-service regulations apply to the employees, and so on.

In a sense, NACA is an operating agency in a sense that it operates its own functions while NASA is not because it contracts. That is one sense of the word "operating." Another sense or meaning of the word "operating" means to go out in the field and do big experiments, as contrasted with staying in the laboratory and doing research. That is a different flavor to the word "operating."

I think one must be careful as to what you mean. Usually, in Government, it is my experience that "operating" refers to the direct control and operation under Government auspices and with Government employees of a particular activity as contrasted to contracting for that activity with a private industrial or nonprofit organization.

Now, in that sense, NACA is an operating organization. The new NASA will have both operations and contracts, because, presumably, the NACA laboratories will continue as at present, but it also has the power to contract for new activities as well as to operate new activities, so, I am just bringing this out to show a possible confusion that the word "operating" may bring out.

The CHAIRMAN. Well, the thought I have in mind is that, in this field of outer space, we refer to that for descriptive purposes. Should two agencies have the same powers and same jurisdiction?

Dr. DUBRIDGE. No.

The CHAIRMAN. And it belongs with the new Agency, if one is established?

Dr. DUBRIDGE. Yes.

The CHAIRMAN. Now, projecting your mind into the future, can you see whether this new Agency will—where these discoveries that you know can be put into practical operation, the ones you know now, and what may flow, say, from the peaceful purposes; can you see the new Agency having regulatory powers?

Dr. DUBRIDGE. Again, it depends upon the definition of the word "regulatory." A regulatory agency, like a public-service commission, is regulating the activities of a lot of private, independent corporations and activities serving the public, no doubt. But still thay are private, independent, self-sufficient, and self-capitalized activities or corporations. And the Government regulates their activities for the public good.

Now, in this field I do not at the moment see a lot of private organizations shooting rockets to the moon, or doing other things that have to do with real space exploration except as they do this under a contract with this new agency.

In other words, it is not an activity that is going to give itself over to great private enterprise and therefore regulation of private enterprise in the sense of a public service commission will not be necessary.

But I do think, on the other hand, that it is very important that the United States Government have control of the activities which go on in the United States in the space field and not every Tom, Dick, and Harry should be allowed to shoot rockets off into space.

The CHAIRMAN. That involves regulatory power?

Dr. DUBRIDGE. Yes.

The CHAIRMAN. Furthermore, we know the setup of the AEC, and, of course, under the law any individual or any corporation or any group who makes a new discovery which is in no way connected with Government funds or entitled to the benefit of that—as I remember it, if they applied for a patent, the Atomic Energy Commission must be notified and if the Atomic Energy Commission considers that to be in the national interest in connection with our defense, they can stop a patent being issued; they can take it over; they compensate the individual or group, because the national interest is involved.

So that the AEC does have either direct or indirect control over all new discoveries, even those made purely in the private field.

Dr. DUBRIDGE. That is correct.

The CHAIRMAN. And there are other methods of control also.

That is what I had in mind when I was asking some questions of Dr. Furnas. I am sure that if he had in mind what I did, he might recognize we just cannot have people, corporations, or others, having great secrets where the national interest of our country is involved to the exclusion of the Government. And that involves some degree of regulatory power; is that correct?

Dr. DUBRIDGE. Yes.

The CHAIRMAN. Furthermore, if a corporation makes a discovery which is not considered in the national interest where under law we

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step in and compensate and take over, or they can provide that it be made classified, the details of the new discovery, even if the Government does not take it over, can be classified. That is regulatory power. That might exist in this agency.

Is that correct, Doctor?

Dr. DuBridge. I assume it would be correct if it was judged that the new discovery or invention had military security importance.

The Chairman. Yes. I said in connection with the national interest.

Dr. DuBridge. Yes.

The Chairman. And even if a corporation made a discovery which was not considered such and the Government makes a contract with another company on some end product, the Government can use that discovery, let the new company, the second company, use it, although they have got to compensate the first company.

Dr. DuBridge. The AEC can, yes.

The Chairman. One can see there has to be some degree of regulatory power. And as these discoveries become more and more practical they might increase?

Dr. DuBridge. If instead of using the word "regulatory" we use the word "control" or "direction," it becomes I think, clear that we want to give direction to our space program and that a single agency must give direction.

It must do it through the mechanism of regulation.

The Chairman. Mr. Hays?

Mr. Hays. I have no questions, Mr. Chairman.

The Chairman. Mr. Metcalf.

Mr. Metcalf. I would like to——

The Chairman. Oh, pardon me, Mr. Metcalf, for just a moment.

Doctor, I notice your interest is on the civil side in connection with space activities. Would you look this bill over, and if you have any suggestions to make as to your views in which you think the committee might strengthen it, would you submit that, please?

Dr. DuBridge. Yes.

Mr. Metcalf. Just so that I may understand your ideas of how this is to be organized:

In addition to this operational use in two senses, that is, actual laboratory experimentation, and contracting, there has to be some directional authority, does there not, in any agency?

Dr. DuBridge. Yes.

Mr. Metcalf. It seems to me that we were talking about the Weather Bureau this morning. Now, this new space has very important connotations for weather.

But the direction has to be in the new Space Agency rather than in the Weather Bureau.

Dr. DuBridge. I would think so, yes, sir.

Dr. Pickering. I would like to comment on that.

The new Space Agency, as I see it, is going to have to work with a variety of different agencies, universities, scientific groups of various sorts.

Mr. Metcalf. Private business organizations?

Dr. Pickering. Yes.

To bring the whole picture together, yes.

Dr. DuBridge. The National Science Foundation and the military.

Dr Pickering. Yes.

Mr. METCALF. In fact, at some time or other, maybe all the branches of the Government—maybe, for instance, the Forest Service may want to have something to watch out for fires instead of having another system; but they could not launch a satellite.

So, they would go to the National Space Agency, which would have the directional authority and control and maybe employ the Weather Bureau to carry out the research?

Dr. DUBRIDGE. Yes.

Yes, I think that you have expressed exactly the thought that I was trying to express as to the function of this Agency, to direct, control, and coordinate.

Mr. METCALF. I marked one question here.

You said that we must be both bold and careful. And in carrying out that task we have to have initially the best organization; would you not agree?

Dr. DUBRIDGE. Yes, sir.

Mr. METCALF. Now, then, it is all very well to say that the NACA has done a good research job since 1915, or to point out that the Atomic Energy Commission has worked well in handling that nuclear development; but when you testified you said you did not want to compare the difference between having a director over a board and a board over a director.

What, in your opinion, is the best organization here?

Dr. DUBRIDGE. Personally I would prefer an organization here similar to the NACA organization. That is, the Government appoints a board of directors and gives that board authority to employ a president, a director, and then to have that director responsible to the board.

And then all things would flow from there. In other words, have your line of authority from the president to the board of trustees, to the director, and then out to the staff and the operations.

The CHAIRMAN. Why not a commission instead of a board?

Dr. DUBRIDGE. Well, then you have 5 bosses instead of 1.

I prefer a single director and not five directors. A commission means five full-time people. So you have five full-time bosses.

A board of directors or trustees is a normal American free enterprise tradition. We know how to operate with boards of directors.

The CHAIRMAN. The Government is not based on the corporate system.

Dr. DUBRIDGE. Yes.

But you asked me what my preference was.

The CHAIRMAN. I understand.

Dr. DUBRIDGE. My preference is to use the American system, a board of trustees or a board of directors. All of our universities and corporations operate on this basis.

It sets policy and direction and is responsible for the appointment of a director. And he carries out these things.

The CHAIRMAN. I do not want to see the day that they would act as a unit.

Dr. DUBRIDGE. Their final vote is a vote of a body. But when you have a commission, then you have five different people sharing responsibility, and I think this is bad organization.

The CHAIRMAN. Do you think the AEC would be better off if it had a board of directors and a single operator?

Dr. DuBridge. I think the AEC would be better off, yes, if it had a board of directors and a single operator.

The Chairman. A very serious question.

Dr. DuBridge. I know it is.

I say this with some hesitation. But I have watched the AEC work for 10 years.

The Chairman. According to what man is the head; is that right?

Dr. DuBridge. The man that is the head makes an enormous difference.

The Chairman. Whether he is rather dictatorially inclined or not, and all those things, you think?

Dr. DuBridge. Any organization can be wrecked by a bad man.

Another reason for a board of directors rather than a commission of full-time people is that it would be extremely—or it is extremely difficult to take the best scientists, the best industrialists, the best lawyers from private activities and bring them in as full-time Government employees.

The AEC, as you know, has got some very good people, but they have also been turned down by some awfully good people who will not leave their private practice or private business to go into the Government.

Now, this board of directors of the NASA could be comprised of the best talent in the country that nobody would turn down, being a member of this board. It would mean maybe 15 meetings a year. It would be an important job. It would not interfere with his private practice.

So, you could command the best brains of the country. I would rather have the part time of 17 of the best brains in the country than the full time of many more mediocre ones.

The Chairman. What do you think, Dr. Pickering?

Dr. Pickering. Well, my own feeling is that the divided responsibility of a commission is dangerous, is conducive to confusion, shall we say; that there should be one firm head of the agency; and one of the reasons I say this is that the agency is going to have to have a very positive program in the hardware sense. It is going to have to get out and say we will fire this on schedule and it has got to get out and make sure that its research program moves along steadily.

And this will be much easier when you have one definite head of the agency. So, I am in favor of having a definite director of the agency.

Now, whether he should report directly to the President or whether he should report to a board of 17 members I do not feel as strongly on this as Dr. DuBridge does.

Mr. Feldman. While we are on this subject and before we lose our train of thought, I would like to pursue this idea of the board of directors.

You are aware, Doctor, of course, that there are all kinds of boards of directors. And I mean by that this: I sit on some boards. I know of at least one instance in which the chairman of the board of directors, who is the principal stockholder of the company, can tell that board just exactly what to do. And if anybody disagrees with him, he does not stay on the board very long.

There are, on the other hand, boards in which there are various cliques, and the president of the company, or the director in this

instance, plays these different cliques against each other; so that the best interest of the organization sometimes is jeopardized by that fact.

So that when we talk of a board of directors on top, it is not just this harmonious thing that we are speaking of all the time, you know.

And sometimes for the good of the company there are disagreements and whatnot. So that when we speak of one versus another we have got to think of all these various shadings.

Wouldn't you agree on that?

Dr. DuBridge. Certainly.

I do not think one can guarantee that either board will be good or competent no matter which way it is set up. But I just prefer the board of directors.

But I realize that the recent trend of Government has been the other way. And I would have no violent objections if for political reasons it were decided that the NSF—the National Science Foundation—plan rather than the NACA plan were adopted.

But if you are asking my preference, I have given it.

Now, a very important aspect in either case will be the quality of people chosen by the president for the board. If the president is forced for political reasons to have somebody from every part of the country, to have somebody from each racial origin, or caste, or color, or creed, or to have so many Republicans and so many Democrats, and all the rest of it, instead of appointing the best men, then a board can be ineffective and dangerous.

Mr. Fulton. The question is: Suppose you had 5 men of different characteristics, 1 of whom might be a fine administrator, and 1 of whom might be a fine aeronautics person, and 1 of whom might be a very good propellent person, and 1 of whom might be a good astronautics or astronomer type, and we might also get somebody who had a financial brain to protect the taxpayers, wouldn't that kind of a commission setup be more rounded than trying to get somebody in this vast new field who was trying to be the czar, like the Manhattan Project that Congress moved away from, and being all things to all men, making decisions in so many fields, and so many different levels?

Dr. DuBridge. Well, I personally do not think that that would be better for the following reasons:

First, this man cannot be a czar, because the board of directors is there. Whatever capacity it is in, this board of directors is there to guide him, to set policies, to steer him on the right path.

Secondly, if you have got 5 fine people in 5 different fields, I would make 1 boss and the other 4 vice presidents and give each one operating responsibility in the field of his specialty but under the boss.

Mr. Fulton. If this director you are speaking of is confirmed by the Senate and appointed by the President, how could the board of directors then fire him or really control him?

Dr. DuBridge. Well, they couldn't under those conditions. That is why I prefer the other arrangement.

But even under this other arrangement where the director is appointed by the President and the board is more advisory, I am of the strong opinion that if the director proved to be incompetent or seeking his own self-aggrandizement at the expense of the Nation, that this board of directors would quickly spot that and would certainly report to the President, and strongly recommend that some action be taken.

Mr. FULTON. Thank you.

The CHAIRMAN. All right, Mr. Metcalf.

Mr METCALF. I want to thank both of you for forthright answers, because this is going to be a very important question.

And this conflict of opinion that is appearing before this committee is going to help us resolve this very question. And the answers you have given are beneficial and most informative.

And, of course, we would not want a harmonious board, would we, necessarily, if it is going to set policies in new areas?

Dr. DUBRIDGE. I am sure there would be disagreements no matter what kind of board you appointed.

You would expect that.

Mr. METCALF. Yes.

Now, what would be the optimum for such a board?

Dr. DUBRIDGE. That is very difficult. I would say that 5 is too few for the Board of Directors that I am talking about; but I would prefer fewer than 17.

I think 17 is a little large. I would say 9 or 11 would be better than 15 or 17 and would be better than 3 or 5.

That is my reaction.

On the other hand, I recognize that there are many fine boards around the country. The board of trustees of my own institution is a board of 30 people. They get along pretty well, and do what I think is a very fine job. So, it isn't necessary that a large board be appointed.

Mr. FORD. They made a good selection of president.

Dr. DUBRIDGE. So, I would prefer about 11 to 13.

Mr. METCALF. A board somewhere between 9 to 11, you think?

Dr. DUBRIDGE. Yes.

Mr. METCALF. Do you have any ideas on that, Dr. Pickering?

The CHAIRMAN. The doctor thinks there should be a strong director.

Mr. METCALF. But we are going to have a board in either of the systems.

Dr. PICKERING. It is an advisory board, perhaps.

The CHAIRMAN. I wanted you to clarify that.

Dr. PICKERING. I would say 20 is too many. But whether it should be closer to 10 or 17 I do not have any very strong opinion on that.

Dr DUBRIDGE. A little depends, of course, on whether you require certain representation on the Board.

Now, if you are going to require that there be a representative of the Department of Defense and the Army, Navy, and Air Force, and the National Science Foundation, and the Weather Bureau, and a half dozen other Government agencies, so you have about 11 people that are ex officio, then I think you need another 8 or 9 to do the work.

Mr. METCALF. Which brings up my next question.

Where do you think the respective areas of the military and the civilian agencies should be in this Board, and what representation should each have?

Dr. DUBRIDGE. Well, that again is a difficult question.

Mr. METCALF. You have read the bill and you know how it is divided in the bill.

Dr. DUBRIDGE. The bill, I think, says at least one shall be from the Department of Defense.

If up to 8 are from Government agencies, then obviously a total board of 11 would not be adequate.

Mr. METCALF. That is right.

Dr. DUBRIDGE. I would prefer to have 9 or 11 people chosen mostly outside of the Government and then have the Government represented through liaison offices, or ex officio liaison attachments of some sort, rather than as members of the Board itself.

But, again, this is getting into an administrative matter on which I only have slight preferences and they are not terribly strong feelings.

Mr. METCALF. Well, in your opinion—and I hope you will interrupt, Dr. Pickering, if you have any differing ideas as we go along——

The CHAIRMAN. Mr. Metcalf, would you permit me to ask this of you: Mr. Fulton has to leave on a plane at 4 o'clock. He has two questions. He wanted me to ask them. But I thought it would be better if he asks them.

Mr. METCALF. I would be glad to yield, Mr. Chairman.

Mr. FULTON. Thank you.

I have just written these two questions out as I was sitting here.

In planning an interplanetary trip to Venus, the planet closest to the sun, or to Mars, the planet farthest from the sun, does it make any difference as to the time of leaving the earth's atmosphere? For example, sunrise or sunset, midnight or high noon?

A second question is: In a trip to a planet closer to the sun than the earth, should the gravitational force of the sun be used as a practical power factor once the space vehicle leaves the earth's proximity?

Dr. PICKERING. In answering those questions, the particular time of launching for another planet is governed more by the relative positions of the earth and the planet in their journeys around the sun.

And then you choose the correct point on the earth's surface, depending on just where they are. In other words, this is tied up with what is the travel time to the other planet. During this travel, the planet is moving, and the whole problem is a fairly complicated problem. I do not think one can categorically say you should launch at sunset or noon, or anything of the sort.

Mr. FULTON. You do not try to take advantage of the earth's rotation?

Dr. PICKERING. Yes. You take advantage of the earth's rotation. And you also, of course, are flying in the sun's gravitational field and, therefore, the sun's gravitational field must be taken into effect.

For example, it is easier to go to Venus than it is to Mars, because to go to Venus you fall in toward the sun; to go to Mars, you have to climb out of the gravitational field.

Mr. FULTON. There has been some testimony here that you could take practical account of the gravitational force of the sun in our planetary system as a power or propellent.

Dr. PICKERING. It is not a propellent in the usual sense. You are moving under the influence of Newton's law.

Mr. FULTON. But it is sufficient enough to take account of?

Dr. PICKERING. Yes.

Dr. DUBRIDGE. On the other hand, you have to come against it when you come back out.

If you send something into Venus, you accelerate due to the sun's pull, but as you come back out, of course you decelerate again.

You have to work against the sun's gravity in coming back to the earth.

Mr. KEATING. It is better not to get there than to get there and not be able to come back?

Dr. DUBRIDGE. It depends upon whether there is a man aboard or not.

The CHAIRMAN. Mr. Metcalf.

Mr. METCALF. I think that it has been developed here not only through the testimony that has been presented here today but as accumulation of this testimony, that in addition to the policymaking position of the military on a board of directors or a commission or whatever they are represented on, there must be constant and continuous liaison, not only with the military but with these other operational agencies?

Dr. DUBRIDGE. That is right.

Mr. METCALF. Now, would you write that into the law, or would you make a statement in the declaration of policy for such liaison?

Dr. DUBRIDGE. I would put some provision in the law to establish a mechanism for liaison or coordination between the military agency, whatever it is, after the new reorganization and the new civilian agency, NASA.

I would write something into law to provide for that link, either joint board membership if that seems to be best, or a liaison committee such as the AEC has, or some other mechanism, I think, ought to be written in just to insure that it is the intent of the Congress that there shall be close relation between these two agencies, as there must be.

Dr. PICKERING. I would go further than that and say this program cannot succeed unless there is close cooperation between NASA and the military, because the vehicles which must be used in at least the first few years of existence of NASA must be vehicles which have been developed by the military for their own purposes.

Mr. METCALF. Would you go so far as to say that, in addition to policy liaison at a relatively high level, there has to be a day to day working liaison at a lower operational level?

Dr. DUBRIDGE. Of course.

Dr. PICKERING. I would think so.

Mr. METCALF. Both of those should be written into the law.

Dr. DUBRIDGE. I do not know how to write the second.

Mr. METCALF. The military liaison committee may be an analogy for the lower level, and then if you have a part-time board, of course you would have representatives of the Department of Defense on the policy board.

I was thinking of something along that line.

Dr. DUBRIDGE. Yes; but at the lower level—I thought you meant the working level—that means that if you have——

Mr. METCALF. Well, that would have to be worked out with the military liaison.

Dr. DUBRIDGE. The NASA, for example, is going to have some laboratory operations and plans some launchings and it is maybe going to use a Jupiter booster. And it is going to have to work with the Army Ballistic Missile Agency at Huntsville on the redesign or modification or schedule or launching and whatnot.

This will have to be a close working relationship that you cannot write into the law.

Mr. METCALF. That would have to be an administrative policy.

Dr. DUBRIDGE. Yes.

Mr. METCALF. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. This morning quite a bit of confusion resulted over the duties and responsibilities of the National Science Foundation.

As pointed out by Dr. DuBridge, the National Science Foundation is not an operating agency. As a member of the Committee on Appropriations—I am not a member of the Subcommittee on Independent Offices—I felt that I knew a little about the duties of the National Science Foundation and what the responsibilities were of this particular organization.

Now, this morning I almost changed my mind. Mr. Chairman, this Foundation, under its basic act of 1950 is authorized and directed to develop and encourage the pursuit of a national policy for the promotion of basic research and education in sciences.

Further, to initiate and support basic research in the mathematical, physical, and other sciences by making contracts and other arrangements for the conduct of basic science research and to appraise the impact of the research upon industrial development and upon the general welfare.

Now, the chairman of this particular subcommittee is a friend of every member on this committee. And I know the chairman will be interested in his remarks at the time the Director appeared before this particular subcommittee for its annual appropriation this year.

His statement was to this effect, Mr. Chairman:

> In other words, this Foundation operates under very broad, general language and is placed in a position of trying to lead and lead through persuasion.
>
> It does not have the authority to go out and establish a laboratory and to operate it itself. It has authority to give some money to some bright folks. The Science Foundation has the right to select these people.
>
> We do not tell you whom to pick or how to pick them. The Foundation has the authority to grant money to educational institutions for facilities.

Now, Mr. Chairman, that is the National Science Foundation. There is no conflict as to the bill before this committee and the duties and purposes of this particular Foundation.

And Dr. DuBridge, I believe, you agree with that statement; is that right?

Dr. DUBRIDGE. Yes; I do.

Mr. NATCHER. I want to thank you and Dr. Pickering for the fine statements you have made to this committee. I think both of you gentlemen understand the bill that is before the committee and the purpose of this bill and you have made fine statements and I want you to know that we appreciate it.

The CHAIRMAN. I think that is very valuable information you gave. I did not know about that. I did not think there would be this conflict or competition. If so, I do not think it should exist if we are going to establish a new agency.

Dr. DUBRIDGE. May I add one footnote to this point. I think it is quite likely then in its support of science that the National Science Foundation might be asked by some university to support a program which involves sending up a satellite for cosmic ray studies or some other scientific purposes. The National Science Foundation might be faced with a question, shall they grant so many thousand dollars to such and such a university for creating the instrument which

might be put in a satellite for scientific research. I think this is the kind of thing Dr. Furnas had in mind.

The National Science Foundation might say, "This is a good idea to give the University of Iowa a contract to create scientific instruments for a particular program of research which instruments will go in a satellite," but at this point I would say the Science Foundation would have to go to the new NASA and say, "gentlemen, we have a fine research idea here. We are willing to support it, the instrumentation which is going to be developed at the University of Iowa provided you, the NASA, will furnish the satellite vehicle to carry the instrument in some of your future flights." This is where it might be the two would come together.

Dr. PICKERING. Might I add to that? In a sense that has been the way we have operated during this past year or so in the International Geophysical Year. We have had this IGY Committee on the earth satellite program which has been under the National Academy's jurisdiction and the United States National Committee for the IGY, and this Committee then has selected scientific programs which have been suggested to it and has funded the scientific program. The actual flight testing, of course, involves the committee essentially going to the Department of Defense, in this case the Vanguard project, and saying "This is what we believe you should fly on this test," and then the Department of Defense provides the vehicles.

The CHAIRMAN. That is a question of relationship to understanding men. There will no doubt be twilight zones and we cannot legislate on every twilight zone.

Dr. PICKERING. The thing is that this is a mechanism by which a researcher in the University of Iowa, say, is able to get his instrumentation development done and to get his program put in a satellite. I visualize very much the same sort of mechanism working with the NASA.

The CHAIRMAN. Do you think the IGY should be extended, Dr. Pickering? I have heard some even mention a decade.

Dr. PICKERING. Let me start by saying that the IGY is an international effort that was planned for a certain period of time.

This involved a large international scientific effort in certain areas of science. One would like to think that the impetus of this IGY period would indeed carry on in supporting much of this scientific endeavor beyond the particular period when it was a broad international affair.

Dr. DUBRIDGE. But to continue the same type of intense and concentrated effort that IGY has involved would be a little difficult because a lot of people have left their normal pursuits and are concentrating their efforts on this particular program.

I would however hope very much that the international collaboration in science which the IGY has initiated in many fields could be continued on a reasonably permanent scale.

Mr. FORD. Is this the first IGY in the history of mankind?

Dr. DUBRIDGE. No; the third.

Mr. FORD. How far back have they gone?

Dr. PICKERING. The second was 1932. The first one was 1882. There had been an expectation that the third would be scheduled in another 50 years.

The decision was to make that 25 years because of the great advance in instrumentation and technology.

Mr. KEATING. This mean that you will go after the next one a couple of years from now.

Dr. PICKERING. I don't know. I think the amount of data we have accumulated will take 25 years to analyze.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Dr. Pickering, you mentioned on page 3 of your statement "such a program must be coordinated with the scientific community." Just how broad or how narrow do you have in mind when you refer to the scientific community?

Dr. PICKERING. I am thinking of something like the present technical panel on the earth satellite program which is under the IGY activity but which is inviting contributions from all of the scientific community interested in this type of program. I am also thinking of one other activity and that is the upper atmosphere rocket research activity in this country which has been coordinated on essentially a voluntary basis by the scientists interested in this program.

Here again the people concerned have gotten together and have tried to make an organized and systematic program. I would believe that something like this rocket research panel or the IGY technical panel on the earth satellite program, something of that sort, could very well continue, possibly under the support of the National Science Foundation.

Mr. SISK. Of course, I would appreciate it when you and Dr. DuBridge extend your remarks, which I assume you will be permitted to do in the record, if you will comment on what extent you feel we should carry on worldwide scientific cooperation; realizing, of course, the contribution of security and so on. I do not want to take the time of the committee now to go into that, but I do think it is significant in this particular field.

As I understood your statement, Dr. DuBridge, you feel that definitely this exploration of space is something that should not be overly classified as I understand.

Dr. DUBRIDGE. That's right, and I think it should be international because a space vehicle is not like an airplane. An airplane can circle around over a particular country and stay within the boundaries. A satellite knows nothing about boundaries, it has to cross international boundaries all the time. Therefore, it is almost inherently an international object, although one country sends it up. Also it is almost inherently impossible for a country to prevent its crossing its boundaries. Therefore, you have the inherent problem of internationalization built into the satellite. Therefore I would like to see this properly taken advantage of and exploited. We should take the lead, as the President has done, in proposing international collaboration in peaceful satellite and space exploration.

It certainly is a fine way to take a lead on international cooperation.

Dr. PICKERING. Supposing, for example, you consider a problem, stepping beyond the satellite to an interplanetary type of vehicle. Here is a vehicle traveling out into space to Mars. You are sitting on the earth and you are interested in what is happening to that vehicle. The earth is turning around every 24 hours. If you want to look at the vehicle you will have to have a ring of stations around the earth, probably around the equatorial regions. Most of those stations will not be on United States territory, so again one is forced into international cooperation in such a program.

Mr. SISK. In these comments you may put in the record if you feel there is any implication or any application wherein the bill which we have before us might require some legislation or some authorization for NASA to provide our part of the worldwide cooperation.

Mr. Chairman, thank you.

The CHAIRMAN. Either the NASA or the State Department.

Mr. SISK. Or the State Department or such other agency; in other words, whether or not note of that should be made in the legislation.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. In connection with our discussion this morning about the research and scientific authority of this Agency and its operational authority, since the recess I have found a document that outlines a National Space Establishment. It is the recommendation of the American Rocket Society and Rocket and Satellite Research Panel.

It is dated January 4, 1958, which is comparatively recently. I think in that connection that it would be a good place to insert it in the record.

The CHAIRMAN. Without objection it is so ordered.

(The document referred to follows:)

The American Rocket Society and the Rocket and Satellite Research Panel have independently studied a national program for space flight. This summary document, prepared by officers of both of these organizations outlines the basic premises which are common to both of these proposals.

SUMMARY OF PROPOSAL

It is proposed that there be created a national space flight program and a unified National Space Establishment for the purpose of carrying out the scientific exploration of outer space.

It is imperative that the United States establish and maintain scientific and technological leadership in outer space research in the interests of long-term human progress and national survival.

1. *Role.*—The role of the National Space Establishment shall be to unify and to greatly expand the national effort in outer space research and in the practical utilization of space capabilities specifically excluding space weapon development and military operations in space which are considered to be the responsibility of the Department of Defense.

2. *Mission.*—The broad mission of the National Space Establishment shall be to establish United States leadership in space research and other nonmilitary space operations by 1960 and to maintain it thereafter.

Accomplishment of this mission requires the following specific achievements:

(*a*) An intensified program of scientific soundings with high altitude rockets, immediately.

(*b*) An intensified program of scientific and technical developments with small instrumented satellites of the earth, immediately.

(*c*) Impact on the moon with nonsurvival of apparatus, by 1959.

(*d*) Placing an instrumented satellite in an orbit about the moon, by 1960.

(*e*) Launching of an instrumented vehicle, into an independent heliocentric orbit between Earth and Venus by 1960, to improve the accuracy of astronomical constants, and to explore environmental conditions in interplanetary space (meteoritic matter and interplanetary plasma).

(*f*) Impact on the moon with survival of scientific instruments, by 1960.

(*g*) Sending an instrumented comet to circumnavigate the planet Venus by 1961

(*h*) Returnable, manned satellites in flight around the earth, by 1961 or 1962.

(*i*) Small inhabitable permanent satellites by 1963.

(*j*) Manned circumnavigation of the moon with return to the earth, by 1965.

(*k*) Manned expedition to the moon by 1 or 2 men by 1968.

(*l*) Establishment of a permanent human base, if desired, beginning 1970.

(*m*) Fast-manned reconnaissance flight to Mars and Venus without landing, beginning 1972.

A thorough analysis of existing capabilities shows that all of these objectives are within reach of a unified, vigorous national effort.

3. *Administrative status of National Space Establishment.*—(*a*) It is strongly desirable that the NSE be given statutory status as an independent agency in order that its work can be freely directed toward broad cultural, scientific, and commercial objectives. Such objectives far transcend the short term, though vitally important, military rocket missions of the Department of Defense.

(*b*) If the proper creation of an independent agency is judged to require an intolerable delay, then it is believed that the statutory existence under the Secretary of Defense (but not within the jurisdiction of anyone of the military services) will be a workable arrangement for the immediate future. But in this event, it is urged that the charter of the agency explicitly provide for its independence as soon as its stature and achievements make this advisable.

(*c*) It is emphasized that the National Space Flight Establishment should not have "defense" missions in the direct sense of this word, since such missions would necessarily place it under the jurisdiction of the Department of Defense. The military use of space and the development of space weapon systems should be directed by the Department of Defense, whose duty it is to coordinate the weapon development of the three military services. By separating the above-mentioned scientific, cultural, and commercial objectives of the NSE from the military objectives of the Department of Defense, the eventual administrative separation of these two agencies becomes clearly desirable.

(*d*) It is explicitly advised that the National Space Establishment not be placed within the jurisdiction of any 1 of the 3 military services. There are many reasons, growing out of extensive professional experience, for this view. The military services are basically operating agencies, not research ones. The research talent of any branch of the military services is almost inevitably turned toward helping meet short-term, limited objectives. Such a point of view would assure the failure of a National Space Establishment in its broad mission—which is truly a national one, far beyond the mission of any one of the services or the Department of Defense taken as a whole. During the early phases of space research, it is evident that existing facilities and existing missile technology of the Department of Defense can make enormous contributions. The National Space Establishment must be set up in such a way that it enjoys the unqualified support of all three services, and not merely one of them. Such a situation is believed to be possible only if the NSE is an independent agency from the outset or if it is directly responsible only to the Secretary of Defense during its early years—with the clear prospect of independence at the earliest possible date.

(*e*) There must be clear channels for mutual cooperation between the proposed NSE and all levels of the Department of Defense, in order to assure no jeopardy of short-term, vital military need on the one hand and in order to assure maximum rate of advance of space research on the other.

4. *Remarks on the long-range importance of space research.*—It is already clear that international leadership hinges, to a very great extent, on preeminence in scientific and technological matters.

Space research will contribute enormously to the educational, cultural, and intellectual character of the people of the United States and of the world. Indeed, the exploration and eventual habitation of outer space are the finest examples of the "endless frontier." It is for such bold endeavors that the highest motives of men should be invoked.

There will be a rich and continuing harvest of important practical applications as the work proceeds. Some of these can already be foreseen—reliable short-term and long-term meteorological forecasts, with all the agricultural and commercial advantages that these imply; rapid, long-range radio communications of great capacity and reliability; aids to navigation and to long-range surveying; television relays; new medical and biological knowledge, and so forth. And these will be only the beginning. Many of these applications will be of military value; but their greater value will be to the civilian community at large. (To use a homely example, the telephone is certainly a valuable military device, but its importance to the civilian population is vastly greater.)

5. *Availability of technical experts for consultation and participation.*—The Rocket and Satellite Research Panel as well as the technical committees of the American Rocket Society comprise a broad membership of persons of extensive experience in all aspects of the proposed program of outer space research. Its

members are professionally dedicated to national leadership in this field. They offer their services, individually and collectively, in the conduct of the broad mission of the National Space Establishment.

JAMES VAN ALLEN,
Chairman, Rocket and Satellite Research Panel.
GEORGE P. SUTTON,
President, American Rocket Society.

JANUARY 4, 1958.

Dr. DUBRIDGE. Dr. Pickering was a member of this panel and signed this report.

Mr. MCDONOUGH. James Van Alen is one of the signatories and George Sutton is.

Dr. PICKERING. Yes.

Mr. MCDONOUGH. They have made some comments and excellent recommendations here and I think these are in the purview of what this agency would be doing on the basic research and development.

One other point. The other day we were discussing Sputnik No. 2 and I asked the question of how much data we were able to decode from our tracking stations from Sputnik No. 2. They told me to ask you the question, Dr. Pickering because the party I asked did not know.

If we were not able to decode the messages correctly then do you think that Russia was able to obtain more information on outer space in their electronic impulses than we did from ours? First, did we get information directly from it?

Dr. PICKERING. Well, in discussing Sputnik 1 and 2 together, the first information, the primary information, the easiest information to get, was to trace the orbit and to ask ourselves the question, can we learn something useful by analyzing it, the orbit. The answer is "yes," we can and we did.

We learned some facts about the air density which we had not known.

Mr. MCDONOUGH. That is on both one and two or especially two?

Dr. PICKERING. Both of them, about the same, Now the next thing is that as far as the signals from the sputniks are concerned there is one class of experiment which the Russians decided to do and which we did not. Namely, that was ionosphere experiments. The Russians said in effect this is the first time we will put something above the ionosphere which surrounds the earth and we will get signals through the ionosphere and perhaps we will learn something useful.

So they chose their radio frequencies partly with this in mind.

This means now we have a great deal of data which has been collected just by listening to the signals. Without analyzing the signals at all but listening to them, determining their signal strength variations and other electrical properties of the signals. This data has been collected and is in the process of being analyzed. This will be just as useful to us as it is to the Russians.

The third class of information is what kinds of information are you actually sending down on the radio communication link? At this stage of course then you got into trouble because if you listened to the signals you observed that the signals change in some fashion as time went on.

Now the Russians made the statement that the temperature of the instruments was measured by the length of the pulse on the signal. We observed the pulse changing in length, so the temperature was changing. How many degrees was it changing? We would have to ask the Russians for that because we didn't know the calibration.

We just knew there was a change, assuming they were correct when they said the length of the signal was a factor in the change of temperature.

Mr. McDONOUGH. The temperature changed at the different points, in the orbit.

Dr. PICKERING. It is colder in the shadow than it is in the sunlight, this sort of thing, nevertheless here is a piece of information which was coming from the Russian satellite which they said was temperature, which we observed was changing, and it could have been temperature but we have no means of interpreting unless they tell us what the calibration is. On Sputnik No. 2 there is some evidence that the signal which was transmitted was a fairly complex signal. It seemed to have quite a lot of information contained in it and the Russians have not told us what that was.

I think we must also raise this possibility, that just as on Explorer No. 3 we have a transmitter which is turned on when it passes over one of the minitrack stations (that is the tracking network of stations which extend down the coast of South America) every time it goes by you essentially ask it "What do you have?" and it tells you what is on the tape recorder. It runs out in 5 seconds, 2 hours of tape recording.

Mr. McDONOUGH. Does that mean that at each minitrack station we get that information?

Dr. PICKERING. Yes, sir, the minitrack station it is closest to. Every time it goes around the world it comes fairly close to one minitrack station so as it goes over you ask the question, "What do you have on the tape recorder?" It runs out the tape recorder in 5 seconds and tells you what it has. Presumably the Russians could be doing something very similar. In other words, every time the thing came over Russia they could say "What have you recorded in the last pass or couple of passes?" and they could have a tape recorder aboard that and they might be getting information in that way which, of course, we have no information about.

In fact, the list of items which they said were included in Sputnik 2 implies that they probably were doing this sort of thing. In other words, although I said the signals from Sputnik 2 were relatively complex I do not believe they were quite complex enough to have included all the sorts of data they said they were measuring, cosmic rays, solar activity, biological effects, temperature, meteorites, and so forth.

You link all this together and I think it calls for a transmitter which is turned on on command, perhaps when it is over Russia.

Mr. McDONOUGH. In addition to the complex signals you got from Sputnik No. 2 what was the advantage of its weight except to prove that they had a bigger engine than we have, bigger thrust engine

Dr. PICKERING. To carry the dog would require a fair weight. Just how much I do not know but I would guess a matter of several hundred pounds to build a container, put the dog in it, and keep him alive. It would have to be a fairly appreciable fraction of the total weight

Mr. McDONOUGH. So its size was to carry the dog rather than to carry additional instruments that might reflect additional signals to the minitrack stations in Russia? It weighed 1,100 pounds, did it not?

Dr. PICKERING. 1,100 pounds was their statement; yes.

Mr. McDONOUGH. That seems larger than necessary to carry the dog and instruments.

Dr. PICKERING. Yes. Again it depends on the instruments and how much you have tried to miniaturize your instruments.

They have shown photographs of some of the instruments on that device and it does not look as if they took any great care in trying to make them very compact.

Mr. McDONOUGH. Has there been any attitude on the part of the Russians to cooperate with us on the exchange of data, willingly?

Dr. PICKERING. The Russians have not given us any details, any detailed scientific data from either sputnik 1 or sputnik 2. The IGY agreements give them 8 months to do this. The 8 months on sputnik 1 I suppose is just about up, so that they owe us some data.

Mr. FORD. Is the 8 months from the end of the IGY year or 8 months from the time of the experiment?

Dr. PICKERING. I am not sure how that was worded but I believe that the implication is 8 months from the time you do the experiment.

Mr. McDONOUGH. Do you have any opinion as to why the Russians have not shot another satellite into orbit since it has the last two? It has been quite a space of time here during which time we have been shooting ours up.

Dr. PICKERING. No, I have no opinion. I am surprised.

Mr. McDONOUGH. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. Have you advanced farther, Dr. Pickering, in miniaturizing our equipment than the Russians have?

Dr. PICKERING. I will put it this way. On the Explorer, for example, we had cosmic rays, temperatures, and meteorite experiments.

I feel that we did a pretty good job of getting a lot of scientific instrumentation in that 20 pounds total weight. Whether the Russians have tried to do this, whether they have had to do this or not, I don't know.

The indication is that they have got very large vehicles available, so why worry about it, and this could be their attitude.

Mr. KEATING. I gathered from what you indicated however, you thought there was a little padding in their claims as to the information they were getting from their own experiments?

Dr. PICKERING. No, I did not want to imply there has been any padding. I merely wanted to say that I felt that taking their claims as literally correct, that they must have had a transmitter which was turned on over Russia in the same fashion that our transmitter is turned on over our minitrack stations. Most of the information then is contained in that transmitter.

Mr. KEATING. Would it be your judgment that they have gotten more information out of their equipment than we are getting out of ours to date?

Dr. PICKERING. Well, they have done more experiments.

Mr. KEATING. I mean out of their satellites?

Dr. PICKERING. Yes. They have done more experiments with their satellites. If nothing else, they have had a dog up there and they have made some measurements on the dog which we certainly have not done?

Mr. KEATING. Is it not a fact that they did not follow the radio frequency which they had promised to use.

Dr. PICKERING. There is a misunderstanding about that. The IGY went on record as favoring the 108-megacycle frequency which the United States had selected and the Russians said that they would

take the matter under advisement. They did not actually agree, as I remember it, to actually operate on 108 megacycles.

Mr. KEATING. It was anticipated they would, was it not?

Dr. PICKERING. Yes, but, several months before they sent up their satellite, they published the fact they would be operating on 20 and 40 megacycles.

Mr. KEATING. So, you knew, some months ahead of the time they shot the satellite around, they were not going to use the frequency.

Dr. PICKERING. We knew they were going to use 20 and 40 megacycles. We did not know those were the only frequencies they were going to use.

Mr. KEATING. Dr. DuBridge, on page 2 of your statement you say that to leave the earth you have to go about 25,000 miles an hour, roughly.

Dr. DUBRIDGE. Yes.

Mr. KEATING. Now you say if we work the thing out so that we can go 5 times faster than that it still is going to take 10,000 years to reach the nearest star. Now, we are all going to be pretty old. You hear all this talk about going to the stars. Now I want to ask you this. You know, we get great stories here. I want to ask you if this is an old wife's tale or a scientific fact. I have been told that when you get up there in outer space you become ageless, or time does not count; therefore, in 10,000 years you only pass a year or something. Is there anything to that? If that is not true, what is the fact about time?

Dr. DUBRIDGE. I have been dealing here with velocities which are some thousand times less than the velocity of light. That is, the velocity of light is 186,000 miles per second. I have been dealing here with velocities of only 30 or 40 miles per second. The effect that you talk about is an effect that is observed only when one is up to maybe 95 or 99 percent of the velocity of light.

In other words, there is no appreciable time contraction until one gets an object which is approaching the velocity of light; that is something like 180,000 miles per second. When you get up to that velocity, or above, you do begin to get a time contraction in accordance with the theory of relativity. But that velocity is so far beyond any velocity we can now conceive of obtaining with any available object, I have dismissed all relativity considerations in my remarks.

If, at some unknown future time, one can learn how to get out into space and then to get a continuous acceleration which will take you more and more up toward the speed of light, then you will begin to get this contraction of time.

The CHAIRMAN. Would you live longer?

Dr. DUBRIDGE. In accordance with a stationary observer, yes.

Mr. KEATING. If it is going to take 10,000 years to reach the nearest star, and, at this rate, this is a rate that is almost inconceivable for a human being to move, is it not? This modest rate of 125,000 miles an hour?

Dr. DUBRIDGE. Speed does not hurt a human being. It is getting to the speed, or stopping, that hurts. Dr. Pickering reminds me that the earth's speed around the sun is 60,000 miles an hour, so that does not seem to hurt us much. It is not the speed that hurts, but the acceleration. What I am worried about, actually, is the energy, to give an object the energy required to get that up to a speed of 100,000 miles per second.

That takes an enormous amount of energy. It is quite difficult, as it is, to get these objects up to 25,000 miles an hour, or 4 or 5 miles per second, which I say is 50,000 times less than the velocity of light.

Mr. KEATING. How fast did you say the earth is moving now?

Dr. DUBRIDGE. Around the sun, it is moving 66,000 miles per hour.

Mr. KEATING. You and I, then, both of us, as part of the earth, are going around the sun at 66,000 miles an hour?

Dr. DUBRIDGE. Yes.

Mr. KEATING. The reason we can sit here and talk to each other is that we are both going at the same rate, so, vis-a-vis each other, we are stationary.

Mr. DUBRIDGE Yes

Mr KEATING. Is that the same principle on which you would be going around in outer space at 18,000 or more miles per hour and you send a refueling object up there and you get even with that and you can work there just as we are working here because you are both going at the same rate? Is that the same principle?

Dr DUBRIDGE That is exactly the same principle You are going at the same rate, but there is one little difficulty. If you are going in a certain orbit around the earth, then at every point in that orbit your speed is fixed and your period in the orbit is fixed. The laws of motion do not allow for any particular orbit, only for a particular period If you have two objects going around the same orbit, they are going at the same speed and one can never catch up to the other. As soon as it tries to catch up, it will go up to a higher orbit, whereby it will go slower and fall behind

Mr. KEATING You can catch up by giving it more propulsion.

Dr DUBRIDGE. Then you get into a different orbit.

Mr KEATING How do you marry these two things up there?

Dr. DUBRIDGE This is one of the difficulties that the space-platform experts don't always talk about It is the fact that, if you try to have one object and try to catch up with another one in the same orbit, if you try to speed up the one behind, then it does not catch up but it goes to a higher orbit and falls behind

Mr KEATING. They told us you could refuel these vehicles up there. There might be a little jiggle, but you could use electronic devices to maneuver.

Dr DUBRIDGE. Both are going around in a similar orbit, and the centrifugal force, the Coriolis force becomes very important. Therefore, we know when you try to make an object go this way you might have to shoot it this way in order to make it go that way, simply because there are enormous depletions in the apparent direction of motion due to these Coriolis forces, due to the fact that we are rotating around a central object, the earth It can be done if you adjust your propulsion in the right direction. If you want to speed up, you actually slow down, then you might be able to do it.

Dr PICKERING You might remember, on the sputniks, that, as the thing comes into the earth, it gets going faster and faster, it takes less time to go around. So, if you are sitting here on the sputnik and you watch the rocket, instead of the rocket slowing down behind you, as you would expect it to, it is getting ahead of you.

Dr DUBRIDGE. The more friction slows it down, the faster it goes.

Mr FORD Will you repeat that again?

Dr. DuBridge. That is because, as friction slows it down—it does not actually slow it; it simply falls to a lower orbit—draft pulls it in and the speed goes up as it gets lower.

Mr. Ford. Going around the earth faster, or at a faster speed?

Dr. DuBridge. Both; actual linear speed and shorter period

Dr. Pickering. A satellite going around just outside the atmosphere goes about 5,000 miles a second The moon out here 250,000 miles is a satellite going around the earth, but it only goes about 3,000 miles an hour. The higher you go the slower you go.

Mr Keating. The higher you go the slower speed at which you can still keep in orbit.

Mr. Pickering. That's right.

Mr. Keating. Does the absence of a gravity field have any effect on time?

Dr. DuBridge Yes. This is an experiment that some of the physicists would like to do This is a very tiny effect on the rate at which a clock goes, and you can think of an atom vibrating as a clock if you wish. There is a slight effect, the relativity effects on the rate of a clock depending on the gravitational field in which it is located. All clocks on earth of course are in the earth's field. If you could get out a thousand miles that would be a 30 or 40 percent lower gravitational field, therefore there should be a slight change in the rate of a clock but it is only one part in 10 billion or less.

Mr. Keating. Oh, well——

Dr. DuBridge It is of great theoretical but very little practical importance.

Mr. Keating. Is there more to be learned scientifically in a lunar probe which we have learned so much about, from exploring around the moon and looking at it, than there is by actually hitting it?

Dr. Pickering. I would say yes, there is. If you hit it you are done. You hit it once and that experiment is all over. But if you are going out in the vicinity of the moon you might make observations first of all of different parts of the moon, just looking at it, photographing and so forth

Or I could measure the magnetic field of the moon I could measure any electric field due to particles coming from the sun I could measure any residual atmosphere that the moon may have. I can do quite a few things by going near the moon without actually hitting it.

Mr. Keating. It is easier to go somewhere near the moon than to hit it?

Dr. Pickering. Fortunately, yes.

Mr. Keating. Would we know if we hit it now? Maybe I am getting into something classified. But with present equipment would we know if we hit it?

Dr. Pickering. If one considers a relatively small instrumented device going out near the moon and you ask "would you know if you hit it," I would say if you were listening to it and all of a sudden it stopped you might decide it had hit the moon.

Mr. Keating. It might hit a meteor.

Dr. Pickering. Yes, or looking at this thing, how big the moon was and you see it getting bigger and bigger and all of a sudden the thing stops, you might decide you hit it.

Mr. Keating. What stops?

Dr. PICKERING. The signal.

Dr. DUBRIDGE. What he means is if you are taking a TV picture of the moon and it is getting bigger and bigger and then suddenly it goes black.

Mr. FORD. Is it conceivable that when you hit it, it might have some substance that it might not cause such an impact.

Dr. PICKERING. We know there is rock up there. There may be dust on it. The astrophysicists debate how much dust there is on the surface of the moon but there is rock beneath the dust.

Mr. KEATING. How big a dye mark would you have to put on the moon to tell in that way you have it, by telescope?

Dr. PICKERING. If you think of it in this sense that the moon is about 2,000 miles across and how big a fraction of the moon now do you want to cover with dye? Whatever your answer comes out that will be it. If you had 1 square mile it would not look very big in a 2,000-mile diameter device.

Mr. KEATING. Could you see a 1 square mile mark from the earth?

Dr. DUBRIDGE. Just about, with a 200-inch telescope.

Mr. KEATING. I have heard of this talk about putting a dye marker on the moon. I wondered how big an object in the way of a dye you would have to put up there to make it visible to be sure in that way that you had hit the moon

Dr. DUBRIDGE. Something like a square mile.

Dr. PICKERING I would prefer 10 square miles to 1 square mile.

Mr. KEATING. How much dye would it take to do that?

Dr. DUBRIDGE. That is an experiment we could try on earth, to take enough dye to cover 10 square miles of the earth.

It would be a few tons.

Dr. PICKERING. If the moon had a thick layer of dust on it, the dye might disappear under the dust.

Mr. FORD. To identify if you hit it by means of a dye marker, would you have to hit it in an area that we could observe, people sitting here on the surface of the earth and looking at the moon. In other words, you have to hit it on the yellow part in order for us to know. Is that right?

Dr. DUBRIDGE. Of course, all of this side is eventually illuminated by the sun. If this thing went around and hit the back side you never would know.

Mr. KEATING. Gentlemen, there are a thousand other questions along this same line I would like to ask you but I cannot take the time of the committee. I do want to ask you a couple of questions about other aspects of your statement, Dr. DUBRIDGE

I was very much pleased by your statement on page 6:

> I trust that the United States will take the lead in urging that outer space be used by all nations exclusively for peaceful purposes.

Now the President has made statements to that effect. Several Members of Congress, including myself, have resolutions saying that it be the sense of Congress that outer space only be used for peaceful purposes.

Now I realize that could be open to attack of being simply a pious declaration.

Don't you think it would be helpful to our position if the Congress of the United States were to enact legislation along those lines?

Dr. DuBRIDGE. I feel so very strongly, Mr. Keating. I think we have a hard time in our propaganda battle with Russia. We have somehow let the Russians pose before the nations of the world as the peace-loving people and we have not taken as many positive moves toward peaceful things as we might have. Here is one thing we could take without the slightest degree damaging our international security, in fact by improving it.

We could take a lead in advocating a peacetime collaboration of scientific exploration of space as an international enterprise.

I would go further and say that it seems to me that if we attempted a military capture of the moon, for example, that this would quite properly and naturally be resented by the Russians, which would initiate them to take some counteraction.

So that our capture of the moon might well initiate a nuclear war which is the very thing we are trying to prevent. I do not want to get into a nuclear war over who owns the moon. I am willing to fight a nuclear war to keep the Russians off the United States, but to get in a nuclear war over the possession of the moon I think is quite a lot to ask of either the people of Russia or the United States.

This is another reason why a peaceful international collaboration on peaceful space exploration is a thing to be desired.

The CHAIRMAN. If anything like that is done, the time to do it is before the fact rather than after the fact.

Mr. KEATING. That is right. I entirely agree with the chairman. If anybody, including ourselves, or any other nation really once gets a foothold out there it will be an awfully lot harder to get across this idea that that must be a peaceful area out there.

You have the problem of inspection and being sure that somebody does not do you dirty, but just the same it is at least, I think, a constructive step along the right line.

Dr. DuBRIDGE. The Russians might not collaborate but we could make the move. We could initiate proposals and develop a plan. This, for a change, would put us in the position of a peaceful nation rather than a warlike nation. It would be to our advantage to do it.

Mr. KEATING. Let me ask you a word or two about the setup of this Board. You favor this administrative setup, but you would prefer to see the Board at the top and the Director reporting to the Board.

Certainly if you have that, you have to have a Board meeting much oftener than four times a year?

Mr. DuBRIDGE. Yes. Once a month I would think and probably 2 or 3 days at a stretch.

Mr. KEATING. Even under this plan where they consult with the Director, even there you have to have the Board meet more often than four times a year but not as often perhaps as under the setup you propose?

Dr. DuBRIDGE. Yes.

Mr. KEATING. Do you think we ought in this legislation, which is now framed to say not less than 4 times, to actually provide in the law for something more than 4 times a year?

Dr. DuBRIDGE. Yes. I hesitate to put too many detailed requirements in the law on the board and yet I think it would be ineffective if less than six meetings a year were held and it would do no harm to make that as minimum and then let the board adjust its meetings as

the need arose. If you have a conscientious board they will meet as often as needed to do the job. May I ask a question, have you thought about the compensation of these board members who meet a few times a year?

Mr. FORD. Up to $100 per day.

Mr. KEATING. I think that is for consultants.

Mr. FORD. It says on page 4:

Such members shall be paid travel expense and per diem in accordance with provisions relating to persons serving without compensation under section 5 of the Administrative Expenses Act of 1946

Dr. DUBRIDGE. That means $12 to cover hotel and meals

Mr. KEATING. The $100 per day relates to consultants.

Dr. DUBRIDGE. I would like to suggest that $100 a day stipend in addition to expenses be allocated to the members of the board, too, because they won't break even on the Government travel.

Mr. KEATING. Of course, they would be coming from distant places. I would hope some would come from California and that is something to consider Now just one other question. This setup provides for 17, 8 from government and 9 from outside, and it says that the Chairman of the Board shall be an outside member. The suggestion was voiced by 1 or 2 witnesses that that restriction should not be on there, that it should be possible to name the Chairman from either "in-house" or "out-house," how do you feel about it?

Dr. DUBRIDGE. I feel strongly that the Chairman should not be a Government employee, should not be one of the Government representatives, that he should be a public representative on the Board.

Mr. KEATING. Tell us why.

Dr. DUBRIDGE. In the first place the Government representative will have a full-time job in Government from which it will be difficult for him to take too much time off.

Second, it is quite possible he will be in a position where he will have interests which may conflict with other interests in the Government in the space field, I mean if you choose an Army man the Navy would not like it, for example, and there may be other conflicting interests.

I would prefer to get an extremely outstanding, distinguished man, a man who stands high in public regard in scientific and engineering circles, industrial circles, a great American figure, as the Chairman of this Agency.

Mr. KEATING. I want to say, Mr. Chairman, that I feel that these two witnesses today have really given us a great deal of valuable and useful information and I am delighted to have had the privilege of being here and listening to these two gentlemen.

The CHAIRMAN. The whole committee agrees with you.

Mr. Ford?

Mr. FORD. Following up a question or two asked by Mr. Keating, Dr. DuBridge and Dr. Pickering, the question of $100 per day, for example, do you mean all inclusive, both the Government and the outside?

Dr. DUBRIDGE. No; it would not be legal to pay the Government representatives extra.

Mr. FORD. You make the distinction between the members who represent the Government agencies and those who come from the outside.

Dr. DuBridge. I was thinking of the outsiders who come in from private universities and business and give their time to this.

Mr. Ford. We have not had much discussion about the term of the Director. As a matter of fact, I find nothing which indicates how long the Director shall serve. I presume that it is at the pleasure of the President.

Do you feel that that is preferable to a set term?

Dr. DuBridge. Yes, for the Director I think the Board members should rotate.

Mr. Ford. They have 4-year terms and it is anticipated that they shall be staggered?

Dr. DuBridge. Yes.

Mr. Ford. But the Director should be on a no-term basis?

Dr. DuBridge Yes, he should serve at the pleasure of the President or the Board. So he might serve for 10 years or he might be asked to resign in 1 year

Mr. Ford The question that bothers me is the representation of the Department of Defense in this picture. It seems to me that it is preferable that we have, at this point, greater representation by the Department of Defense.

I know it says there can be more than a minimum of one. How do you feel about that at this time?

Dr. DuBridge. Assuming we stay with a 17-man board of which up to 8 are Government representatives and 9 are from outside, let us assume that we keep the limit on Government representation at 8, you will certainly want a representative from the National Science Foundation, from the Atomic Energy Commission, probably from the Weather Bureau, probably the Department of Health, Education, and Welfare some place, Public Health Service; so there are 4 Government representatives that you will probably want.

Maybe someone from the National Bureau of Standards. In other words, there will be quite a number of Government agencies which will have technical or scientific or research interests and that you will want represented.

Now if you in addition require that there be Defense, Army, Navy and Air Force, then you will have four taken up there.

So I would be a little afraid that if you required four from the Defense Department, all the agencies, that there might not be enough to represent the other Government agencies.

I think it would be nice to have a representative of the Central Intelligence Agency to help in providing information about what other countries are doing. You can think of quite a number of Government representatives that ought to be among the eight.

So I would hope that the Secretary of Defense might be able to name 1 civilian representative and let us say that the Joint Chiefs of Staff might be able to select 1 military representative to represent all the military services and have 2 from the Defense Establishment. This would be my thought about it.

Mr. Ford. Dr. Pickering, on page 3 of your prepared text you say this:

> The proposal contained in the President's message of April 2 appears to embody most of these objectives.

I am not clear what you are indicating there.

Dr. PICKERING. By the "most"?

Mr. FORD. Yes.

Dr. PICKERING. I think it is just academic conservatism.

Mr. FORD. It seemed to me from reading that paragraph which appears before that paragraph——

Dr. PICKERING I do not know whether there is any specific statement about long-term funding which I think is a rather important thing.

Mr. FORD. That is the bill, as you know.

It says on page 15, section 9 (a)—

There are hereby authorized to be appropriated without fiscal year limitations

and so forth, which gives the no-year funds which I think is most important. I think you may be referring to the need for that.

Dr. PICKERING. Yes, I certainly think it is necessary.

Mr. FORD. One thing bothered me. About 2 weeks ago I kept reading over the weekend the anticipated expiration of Sputnik No. 2's life.

First, it was going to be on a Friday, then on a Saturday and then Sunday; then finally it expired Sunday night or Monday. Was there any significance to the fact that we could not precisely forecast that?

Dr. PICKERING. No; it just means that we were not able to analyze that kind of decaying orbit accurately. In other words, the life is determined as it comes into the atmosphere by the drag on the object, as it gets into the atmosphere. This is determined by the exact shape of the object, the exact orientation because it won't be streamlined into the breeze.

It may be plowing through this way and that way.

Mr. FORD. And the texture of the material?

Dr. PICKERING. Eventually the kind of material when it becomes very hot, how the material melts and so forth.

There are quite a number of uncertain factors in there. I think to predict it within 2 or 3 days was quite good.

Dr. DUBRIDGE. If one had a large sphere one could predict its behavior much more accurately because you would know what shape it was presenting to air resistance.

Mr. FORD. Have we learned anything about cosmic rays and meteorites from our own two Explorer satellites?

Dr. PICKERING. Yes, indeed. I do not know that I want to discuss them in any detail but I want to say particularly the cosmic-ray data has turned out to be quite interesting and quite unexpected.

Mr. FORD. Have we been surprised by anything we have learned in any of these fields?

Dr. PICKERING. Yes, in the cosmic ray field; yes.

Dr. DUBRIDGE. A report is being prepared on this to be released next week. I am not familiar and I am not sure you are familiar with the content of it. Se we will let the IGY release the report next week.

Dr. PICKERING. The IGY is preparing a report on the scientific information from the Explorer.

Mr. FORD. Speaking of the signals you got back from Sputnik I and II, we have some real experts on decoding in the National Security Agency.

Dr. DUBRIDGE. No use at all.

Mr. FORD. Their equipment does not have any applicability to this?

Dr. PICKERING. No. To take a simple example, I can have a thermometer in here and I can say 10° on that thermometer will represent half a second change in the pulse length or I could make 100° represent half a second. I have absolutely no way of telling whether it is 10° or 100°.

All I can say is that the pulse length changes, that is all. It is not a case of trying to decode it. We do exactly the same thing. When we are sending information down from a missile or satellite we have to put the information in such a form that it can be transmitted over a radio signal.

The exact form you put it in is obviously at the discretion of the experimenter but it is not because you are trying to be secretive about it; it is just that you have to put it into some form and the calibration then is the important thing.

In other words, here's a meter which reads like this. Now what is the meter reading? It can tell you anything you like, you see.

Dr. DUBRIDGE. These are not verbal messages that are being sent down in Morse code. These are instruments that are imposing a change of some sort on the radio signal. Only the fellow who designed it knows what signal is put in what way, on what signal.

Mr. FORD. The code itself has no significance but the relationship to the instruments?

Dr. DUBRIDGE. The calibration rather than the code.

Dr. PICKERING. I might point out in this respect by the way that the telemetering calibrations on the United States satellites have been published, have been made available to the IGY.

The Russians have not.

Mr. FORD. Do you feel that there has been any reconnaissance capability in Sputnik II?

Dr. PICKERING. That is a difficult thing to answer. If Sputnik II can carry a thousand pounds I suppose this is beginning to get up to the sort of weights which you need for reconnaissance capability but beyond that I have no comment.

Mr. FORD. I want to join in complimenting both of you, Dr. DuBridge and Dr. Pickering, on the very helpful and valuable contribution.

Dr. PICKERING. Thank you.

The CHAIRMAN. Mr. Hays?

Mr. HAYS. Doctor Pickering, you spoke of 3 items that you picked up from 1 of the Explorers, cosmic rays, meteorites and what was the other?

Dr. PICKERING. Temperature.

Mr. HAYS. You got readings on all three items?

Dr. PICKERING. That is right. It did exactly what it was supposed to do so far as giving us scientific information.

Mr. FORD. May I ask one further question along that line? If we had not launched Explorer II and we had not gotten this information on cosmic rays, could we have conceivably gotten it from other sources and if so, how long a time would it have taken?

In other words, what was the benefit of getting it this way?

Mr. PICKERING. Let us say we have two ways of exploring the very high atmosphere above the earth or space in the vicinity of the earth. One way is to send a satellite around the earth, the other is to send a rocket straight up from the surface of the earth.

Rockets have been sent up to altitudes of 100 to 200 miles. Now satellites are flying at considerably higher altitudes. In principle one can send instrumented rockets up to even higher altitudes than we have done, so one could get data this way. The disadvantage of the rocket is that it is only up there for a few minutes, whereas a satellite is up there for days.

Take, for example, the cosmic ray phenomena. The cosmic ray phenomena tend to be dependent on the position on the surface of the earth, on the particular state of activity of the sun and magnetic storms on the earth.

Now these things are things which vary from time to time. So if one is really going to analyze what is going on one would like to have data coming in over a long period of time. So, desirably then, this is the way to do it.

Mr. FORD. And probably the only way?

Dr PICKERING. The only way really, yes.

The CHAIRMAN Is there any advantage with respect to what part of the earth the satellite is shot up from into orbit?

Dr. PICKERING. Yes. Again taking cosmic rays that is a sort of good example here. One of the things you are interested in is the magnetic field of the earth interacting with cosmic rays.

To really study this you would like to sweep across the whole magnetic field of the earth. This says you should send a satellite from pole to pole because the magnetic poles are up near the geographic poles. So you would like to send the satellite around that way instead of around the equator, as we have done to date.

The CHAIRMAN. Ours went around the Equator. How did the Soviets go?

Dr. PICKERING. It was nearer to the poles.

The CHAIRMAN. That is more difficult, is it?

Dr. PICKERING. It is more difficult in the sense that the energy required to launch is slightly greater in their case. There is very little difference, actually.

Dr. DUBRIDGE. You get a little bit more help from the rotation of the earth.

The CHAIRMAN. It would take more propulsion to send up one way or the other. Theirs is a little more difficult way?

Mr. PICKERING. Theirs is a little more difficult than ours.

The CHAIRMAN. The last one they sent up indicates a powerful propulsion?

Dr PICKERING. Yes, because the rocket on the first satellite was about the size of the second satellite which of course stayed as one piece. So the first satellite, if you looked at it as a rocket-plus satellite, was very much the same sort of size as the second one.

So both of them were very large.

The CHAIRMAN. I have been informed that the use to which these satellites can be put is manyfold, is that correct?

You can use them for almost any use except putting the human mind in there. In fact that came to me from a friend of mine who was on the faculty of MIT.

Dr DUBRIDGE. That is a little broad. I don't think there would be any use translating things in Greek language. There are lots of different possibilities.

The CHAIRMAN. Instruments can be put in there which can bring back information in practically any and all fields, not in one, and they can be utilized.

Dr. PICKERING. I think the other comment I would like to make is that the kind of information or the kind of application will obviously extend beyond our present concepts into many areas as to which at the moment we can't see exactly what we will do.

This is a matter of exploration. We don't know where the exploration will carry us.

The CHAIRMAN. But you know certain things definitely?

Dr. PICKERING. Yes.

The CHAIRMAN. From what you definitely know, you know that in our own national interest, from all angles, that it should be pursued?

Dr. PICKERING. Yes.

The CHAIRMAN. An agency of this kind is the best means from the civilian side to pursue our scientific activity level?

Dr. PICKERING. Yes, sir

Mr. McDONOUGH. Speaking about the extent to which we can observe through satellites, we are limited, however, from taste and smell, I imagine? You can feel and see. There is no taste and smell to an electronic impulse, is there?

Dr. PICKERING. Well, there is a vacuum up there; it does not taste very good.

The CHAIRMAN. Coming back to ourselves as human beings and our relationship to one another, progress oftentimes is made where the fear exists itself. I do not like it, but oftentimes fear produces it and I think sputnik produced some fear which brought along some affirmative force and action on our part. I am a believer in giving the American people all the information possible because public opinion is a powerful weapon in a democracy and if it is to be rational and sound it has to be informed as much as possible. I recognize the exigencies of national interest and so forth.

What other benefits to mankind might flow from these experiments on the part of our Government or any of our agencies, meaning public and private, and which are not classified for the time being?

Do you gentlemen feel it would be to our advantage to make it known to the public without regard to what the Soviet, itself, might do, even if they employ secrecy?

Dr. DUBRIDGE. Yes, for these peacetime experiments I think full publication of the results is extremely important. You see, if you don't publish them, then we don't know them either.

You can't pass secret letters around to every scientist and engineer in the United States who might be interested. So unless the results are published our own people will not get the benefit of them.

Until they are published they might not get the critical attention that some foreign expert might give them who might reveal additional ideas, new interpretations, new theories, suggest new experiments.

The advantage of publication of nonmilitary data are overwhelmingly in favor of the one who publishes it.

The CHAIRMAN. What is your view, Dr. Pickering?

Dr. PICKERING. I agree completely.

The CHAIRMAN. Assuming the Soviet Union did not make disclosures of information from their two sputniks that were not connected with the military aspect, that fact should not get us into an

isolationist's state of mind where, by way of reaction, we say, "We will not disclose any information even though it is not classified in the national interest of our country."

Dr. DuBridge. No; we would be interfering with our own progress.

The Chairman. We would be showing the world sincerity and that applies to all fields of research.

Dr. DuBridge. Yes.

The Chairman. Gentlemen, I call your attention to page 2 of the bill. On line four, "The Congress further declares that such activities should be"—well, we can change that to "shall" if you want to, don't you think, "shall" would be a better word than should.

Should has a qualification—

shall be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense.

That means that the Defense Department makes the decisions as to what weapons may be peculiar to or primarily associated. Would you agree with that?

Dr. DuBridge. I do not see any other alternative actually. Only the Department of Defense can judge what specific things have specific peculiar military importance.

The Chairman. Suppose the new agency were to take the position that certain information is not peculiar to or primarily associated with weapons systems and military operations, what then?

Dr. DuBridge. How would the difference of opinion be resolved?

The Chairman. How would the civilian agency express its assumption the Defense Department was wrong? Suppose something was more or less peaceful, had peaceful use?

Dr. DuBridge. This is a problem of security.

The Chairman. Would it be your interpretation that then they could go to the President?

Dr. DuBridge. Take it to the National Security Council or the President. But on matters of secrecy and national security that is the Department of Defense responsibility and only they can have the access to all the information which would bear on the question.

The Chairman. You heard Dr. Furnas this morning talk about the mass of data that they have?

Dr. DuBridge. Yes, I know, this is a serious problem of the classification of information. This is one we face now in many areas and we have not solved. It is just a problem we face and you cannot solve that problem in this bill.

The Chairman. That is true. Are there any further questions? Mr. Feldman?

Mr. Feldman. Following the chairman's question in the last connection, there are many gray areas in this kind of situation?

Dr. DuBridge. Yes.

Mr. Feldman. For example, weather is something that certainly has a peaceful value?

Dr. DuBridge. Yes.

Mr. Feldman. The Signal Corps is interested in it, so is the Air Force and so is the Navy?

Dr. DuBridge. Yes.

Mr. FELDMAN. There are other situations just like that. So that maybe a recasting of this language, in order to be more specific, will be necessary. I don't say that it is, but I think it should be considered seriously.

Dr. DUBRIDGE. It seems to me this language is reasonably precise, that this Agency "Shall exercise control except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations."

Presumably that decision as to whether they are or not will have to be made by the Department of Defense in which case the Agency may act in cooperation with the Department of Defense or on behalf of it, in which case a collaborative mechanism will be set up.

The CHAIRMAN. In the world of today, having in mind the prominence and importance of the military, can you see much work for the new Agency to do? What will it have to do?

Dr. DUBRIDGE. Tremendous. There are hundreds of scientific problems which are of no foreseeable military concern or military application which space research will reveal. Cosmic rays, for example.

It may be very important for us to understand this cosmic ray phenomena, the way the sun behaves, its conceivable influence on our weather, lots of other things. Magnetic fields of the earth.

These have no specific military application.

The CHAIRMAN. The military could say they have. Under this language they can.

Dr. DUBRIDGE. You mean so the military can begin investigations of cosmic rays.

The CHAIRMAN. Suppose the military says that is a field primarily associated with weapons systems or military operations?

Dr. DUBRIDGE. I don't think anybody can claim that cosmic rays are peculiar to military operation or primarily associated with military operations.

The CHAIRMAN. Suppose the Defense Department says it is. They make the decision. This is clear language. You create a civilian situation but then you accept everything that is peculiar to or primarily associated with weapons systems or military operations. That covers everything.

Dr. DUBRIDGE. I am afraid you will have to leave that to good sense of the Defense Department, the new Agency or the President.

The CHAIRMAN. Should we put in language in case of difference of opinion that the matter can be submitted to the President? In other words, a precaution.

Dr. DUBRIDGE. You can provide an appeal mechanism.

The CHAIRMAN. That would not interfere with the military I am strong for the military angle. On the other hand if we are going to establish an agency I want to see some agency that has jurisdiction.

Dr. DUBRIDGE. You might provide an appeal mechanism in case of disagreement. You probably have similar problems within the AEC as to jurisdiction or classification. How are those resolved?

The CHAIRMAN. All right, Mr. Feldman.

Mr. FELDMAN. Doctor, the frame of reference for my next question is section 2, 6, of the proposed legislation which begins at the bottom of page 2.

I will read that language:

6 Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof

Then I would refer you to section 6 (4) on page 6 which reads as follows:

Arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and provide as appropriate for dissemination of data collected.

How broadly do you interpret the words, "scientific community"?

Dr. DuBRIDGE. As used here, participation by the scientific community? Well, my interpretation of that would be extremely broad the way it is stated here.

The scientific community certainly, for example, includes scientists of all nations.

Mr. FELDMAN. That was my next question. Would you include scientists abroad?

Dr. DuBRIDGE. I would interpret that phrase, unless it was later excepted, as including scientists of all nations.

The CHAIRMAN. When you are editing your testimony you can in the meantime give consideration to that and elaborate, Doctor.

Mr. FELDMAN. The reason for it, Doctor, is that you know congressional intent is very often obtained from hearings and reports.

The CHAIRMAN. What among scientists does the term "scientific community" encompass?

Dr. DuBRIDGE. Unless it is qualified it would mean the scientific community of the world unless there is something in the context or qualification which restricts it.

You can talk of the American scientific community if you wish but unless it is qualified, I always interpret it as meaning the international community.

Mr. FELDMAN. Would you favor a broader definition?

Dr. DuBRIDGE. In case there is likely to be any doubt about it I would favor inserting a phrase and indicating the international scientific community or the scientific community of all nations or something.

Mr. FELDMAN. I have no other questions.

The CHAIRMAN. Any further question?

Thank you very much Dr. DuBridge and Dr. Pickering. You have been very helpful. Speaking for myself as chairman of the committee and all the members of the committee I extend to both of you distinguished gentlemen our thanks.

Dr. DuBRIDGE. Thank you.

May I thank you for your patience and courtesy.

(Whereupon, at 5:10 p. m., the committee adjourned to reconvene at 10 a m., Monday, April 28, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

MONDAY, APRIL 28, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS
AND SPACE EXPLORATION,
Washington, D. C.

The committee met at 10 a. m., pursuant to recess, in room 219, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack, Brooks, Metcalf, Natcher, McDonough, Fulton, Keating, and Ford.

Present also: George J. Feldman, director and chief counsel.

The CHAIRMAN. The committee will be in order.

We are very glad to have with us this morning the first witness, the Honorable Herbert Loper, Assistant to the Secretary of Defense for Atomic Energy.

Mr. Loper, we will be very glad to hear from you.

Mr. Loper, any questions asked of you that call for classified information, we expect you to tell us so.

Furthermore, you have permission to edit your remarks and in that way clarify what you wish to say.

STATEMENT OF HERBERT B. LOPER,[22] ASSISTANT TO THE SECRETARY OF DEFENSE FOR ATOMIC ENERGY

Mr. LOPER. Thank you, Mr. Chairman. I have no prepared statement.

Mr. Chairman, it was my understanding that you were interested in looking into the functions of the Military Liaison Committee to the Atomic Energy Commission.

I have prepared a small folder here for each of the members of your committee which sets forth some background information. I do not particularly call them to your attention now, but it may be pertinent in the course of our discussion this morning to refer to some of these documents.

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[22] Loper, Herbert B(ernard), retired army officer, government official, born at Decatur, Kansas, on October 22, 1896, the son of Gilbert Lafayette and Hulda Belle (Scott) L, A B, Washburn Coll, 1916, B. S., U S. Mil Acad, 1918, B. S., Mass Inst of Tech, 1921, student U S Army engr sch., 1929-30, Command and Gen Staff Sch, 1939-40, m Eleanor Cameron Opie, May 18, 1922, children—Herbert Bernard, Thomas Cameron Commd 2d lt, U S Army, 1918, and advanced through grades to maj gen 1952; river and harbor construction, 1921-23, 1934-38; mil surveys of Panama, 1923-26; instr engr sch., 1930-33 asst to chief of engrs in charge of prodn a supply of maps for U S armed forces, 1940-44, chief engr, Pacific Ocean Areas, 1944-45; dep. engr., gen. hdqrs, Far East Command, 1945-48, dep asst chief staff, logistics, 1949-50, chief spl. weapons project, also dep asst chief staff for operations, Army Headquarters, 1951-53, ret from army, 1953, chmn. Mil Liaison Com, AEC and asst to secretary defense, for atomic energy, 1954- Served in U. S. Army, 1919. Awarded D S M, Legion of Merit with oak leaf cluster, hon. Comdr of Brit Empire, spl Collar Order of Yun Hui (China) Mem Am Soc of Mil Engrs., Tau Delta Pi. Home: 1 Tallyho Lane, Alexandria, Va Office Sec. of Defense, Washington.

I think they will be useful in understanding the organization and the functions of the Military Liaison Committee.

It was my understanding that it was a consideration as a means for insuring liaison between the Department of Defense and the agency with which you are concerned as a basis for insuring the proper type of coordination.

The Military Liaison Committee is a statutory body established by the Atomic Energy Act, initially the Atomic Energy Act of 1946 and subsequently by the Atomic Energy Act of 1954.

It was established for the purpose of insuring appropriate liaison between the Department of Defense and the Atomic Energy Commission.

Of course, you are fully aware that the Atomic Energy Commission has certain vital and important functions with which the Department of Defense has the greatest interest in that it is by law charged with the development of nuclear weapons or the use of nuclear energy for military as well as civilian purposes and charged also with the production of nuclear materials for use in military application.

With this important function assigned to the Atomic Energy Commission it is, of course, essential that the very closest liaison be maintained between the Department and the Commission in order to assure that the Commission may meet and does meet military requirements for the development of weapons and other applications of nuclear energy

I shall be happy to answer any questions as to how the organization is put together, what its functions are and how it performs those functions, satisfactorily or unsatisfactorily, as the case may be.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Mr. Chairman, I have no questions at this point.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. We are glad to see you here, General Loper. I would like to ask you, Has the procedural and administrative setup of the Military Liaison Committee worked satisfactorily to date with the Atomic Energy Commission?

Mr. LOPER. I believe that it has. It has had the benefit of 11 years of experience, almost 12 years of experience.

Initially, of course, as with any new organizations, there were many flaws found in procedures and methods; questions as to relative authority arose and over the years, have been clarified by Presidential directives, agreements between the Commission and the Department of Defense, and by some changes in the law. So that it is my view, on the basis of about 6 years of rather close experience as, first, a service member of the Military Liaison Committee, and subsequently as Chairman, it has operated very effectively and quite to the satisfaction of both agencies concerned.

Mr FULTON. So that you as the representative of the Department of Defense and as Chairman of the Military Liaison Committee, would say the military development of weaponry systems has been adequately protected through the positions which you have held and the access you have obtained to the Atomic Energy Commission?

Mr. LOPER. Yes, sir; I would say that is right, Mr. Congressman.

Mr. FULTON. Have you any suggestions at the present time as to the current type of liaison—with yourself as Chairman, on the level of the Assistant Secretary of Defense, and the three major branches

OFFICE OF THE ASSISTANT TO THE SECRETARY (Atomic Energy)

ASSISTANT TO THE SECRETARY OF DEFENSE (ATOMIC ENERGY)

HERBERT B LOPER

Col Delmar L Crowson, USAF, Military Assistant

	Civ	Mil	Total
Professional	1	2	3
Clerical	3	1	4
Total	4	3	7

1 Formulation of atomic energy policies, plans and programs for the DOD
2 Advice to the Secretary of Defense and principal members of his staff on atomic energy aspects of DOD policies, plans and programs
3 Representation for the DOD with other agencies on atomic energy matters of mutual interest or responsibility
4 Insuring that Joint Committee on Atomic Energy of the Congress is fully informed on all DOD atomic energy matters

MILITARY LIAISON COMMITTEE ATOMIC ENERGY COMMISSION

MILITARY LIAISON COMMITTEE TO THE ATOMIC ENERGY COMMISSION

HERBERT B LOPER, Chairman

1. Liaison between the DOD and the Atomic Energy Commission
2 Information and advice to the DOD and the Atomic Energy Commission on all atomic energy matters deemed to relate to military applications of atomic weapons or atomic energy
3 Formal channel of communication between the Atomic Energy Commission and the DOD

EXECUTIVE SECRETARY

Col Richard H Free, USA

	Civ	Mil	Total
Professional		1	1
Clerical	2		2
Total	2	1	3

1 Secretary of the Committee and principal assistant and advisor to the Chairman
2 Supervision and direction of the operations of the staff of the Committee

SUMMARY OF PERSONNEL AUTHORIZED

(June 30 1958)

	Civilian P	Civilian C	Military P	Military C	Total
Assistant to the Secretary of Defense (Atomic Energy)	1	3	2	1	7
Sub Total	1	3	2	1	7
Military Liaison Committee to the Atomic Energy Commission					
Executive Secretary		2	1	0	3
Administrative Division		4	3	2	9
Special Projects Division		1	2		1
Materials Protection Division			1		1
Nuclear Power Division		1	2		3
Weapons Division		1	3		4
Sub Total	—	9	12	2	25
Total	1	12	14	3	30

ADMINISTRATIVE DIVISION

Lt Col Howard S Derr, USAF, Chief

	Civ	Mil	Total
Professional		3	3
Clerical	4	2	6
Total	4	5	9

1 Procurement, assignment, and administration of military and civilian personnel matters

2 Administration of
- Records
- Internal security
- Office services
- Budgetary matters

SPECIAL PROJECTS DIVISION

Lt Col Donald E Asbury USMC Chief

	Civ	Mil	Total
Professional		2	2
Clerical	1		1
Total	1	2	3

Analysis, evaluation and interpretation of the technical and administrative aspects of the Atomic Energy Commission related to

- Classification
- Security
- Plant Protection
- Personnel clearances
- Public Information
- Exchange of Information
- Intelligence
- Legislation

MATERIALS PRODUCTION DIVISION

CDR Everett E Roberts, USN, Chief

	Civ	Mil	Total
Professional		1	1
Clerical			
Total		1	1

Analysis, evaluation and interpretation of technical, budgetary and administrative aspects of Atomic Energy Commission matters related to

- Raw materials
- Feed materials
- Fissionable materials production
- Related construction program
- Budget review for major AEC items
- Special products

NUCLEAR POWER DIVISION

Col Merwin B. Forbes, USA, Chief

	Civ	Mil	Total
Professional		2	2
Clerical	1		1
Total	1	2	1

Evaluation and interpretation of technical, administrative and budgetary aspects of all research and development projects and programs within the Atomic Energy Commission which are related to:

- Reactor development
- Basic research in physical science
- Health and safety
- Radiological instrumentation
- Power production

WEAPONS DIVISION

Col Kenneth Withington, USAF Chief

	Civ	Mil	Total
Professional		3	3
Clerical	1		1
Total	1	3	4

Analysis, evaluation and interpretation of technical administrative and budgetary aspects of the Atomic Energy Commission related to nuclear weapons

- Research
- Development
- Military requirements
- Agreements and operational arrangements between DOD and AEC
- Production
- Storage

APPROVED

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of the service being appointed in the discretion of the Secretary of Defense? Can you say how that has worked, or do you have other suggestions or recommendations?

Mr. LOPER. I think this organization is properly conceived and it operates well.

The members of the Military Liaison Committee are seven in number, the Chairman appointed by the President, with the consent of the Senate. The Chairman is responsibile to the Secretary of Defense.

The 6 military members are of flag and general officer rank appointed by the Secretaries of the services; 2 from each of the services with the consent of the Secretary of Defense.

All of these military members have key positions in the atomic energy field in their own services.

Mr. FULTON. At this point may we put in the record the extract from the Atomic Energy Act of 1954, section 27, the Military Liaison Committee.

Might I also refer the witness to the Department of Defense directive of October 5, 1954, setting up the Military Liaison Committee.

You know of that Department of Defense directive, do you not?

Mr. LOPER. Yes.

Mr. FULTON. And with the chairman's consent, may we put in the record the outline of the Department of Defense directive No. 5148.2 of October 5, 1954, covering that same thing.

May we also put in the charts showing the military nuclear power in conjunction with the AEC and the MLC in the Department of Defense, plus the basic research chart.

Then you have with you, do you not, the makeup of the administrative organization, the Military Liaison Committee of the Atomic Energy Commission?

Mr. LOPER. Yes, sir; I have a copy of this.

Mr. FULTON. We will put this in the record, too.

Then on the organization for military application of atomic energy I believe you have prepared a chart showing the relationship up to the President and the two branches of the Congress.

Mr. LOPER. That is correct.

Mr. FULTON. We will put that in the record.

Finally, a chart showing the establishment of the development requirement and military characteristics.

With the chairman's permission we will put that in the record.

Then you have a statement, I believe, do you not, on how the Military Liaison Committee was established pursuant to the act of 1954?

Mr. LOPER. I do.

Mr. FULTON. Will you submit that?

Mr. LOPER. Yes.

The CHAIRMAN. Without objection, it is so ordered.

(The material referred to is as follows:)

EXTRACT FROM ATOMIC ENERGY ACT OF 1954

SEC. 27. MILITARY LIAISON COMMITTEE.—There is hereby established a Military Liaison Committee consisting of—

a. A Chairman, who shall be the head thereof and who shall be appointed by the President, by and with the advice and consent of the Senate, who shall serve at the pleasure of the President, and who shall receive compensation at the rate prescribed for an Assistant Secretary of Defense; and

b. A representative or representatives from each of the Departments of the Army, Navy, and Air Force, in equal numbers, as determined by the Secretary of Defense, to be assigned from each Department of the Secretary thereof, and who will serve without additional compensation.

The Chairman of the Committee may designate one of the members of the Committee as Acting Chairman to act during his absence. The Commission shall advise and consult with the Department of Defense, through the Committee, on all atomic energy matters which the Department of Defense deems to relate to military applications of atomic weapons or atomic energy including the development, manufacture, use, and storage of atomic weapons, the allocation of special nuclear material for military research, and the control of information relating to the manufacture or utilization of atomic weapons, and shall keep the Department of Defense, through the Committee, fully and currently informed of all such matters before the Commission The Department of Defense, through the Committee, shall keep the Commission fully and currently informed on all matters within the Department of Defense which the Commission deems to relate to the development or application of atomic energy The Department of Defense, through the Committee, shall have the authority to make written recommendations to the Commission from time to time on matters relating to military applications of atomic energy as the Department of Defense may deem appropriate. If the Department of Defense at any time concludes that any request, action, proposed action, or failure to act on the part of the Commission is adverse to the responsibilities of the Department of Defense, the Secretary of Defense shall refer the matter to the President whose decision shall be final.

October 5, 1954
No. 5148.1

Department of Defense Directive

Subject. Military Liaison Committee.

I Purpose

It is the purpose of this directive to define the authority and duties of the Military Liaison Committee (hereinafter called the "Committee") and to define the relationships of the Committee with the military departments and other agencies of the Department of Defense, and with the Atomic Energy Commission (hereinafter called the "Commission").

II. Authority for issuance

This directive is issued pursuant to the Atomic Energy Act of 1954 (hereinafter called the "act") which establishes the Military Liaison Committee and the authority vested in the Secretary of Defense by the National Security Act of 1947, as amended, and modified by Reorganization Plan No. 6 of 1953.

III Directive superseded

This directive supersedes Department of Defense Directive No. 5148.1. Subject: Military Liaison Committee, dated April 13, 1953.

IV Membership of the committee

The Committee shall consist of:

A A Chairman who is the head thereof and who is appointed by the President as provided for in the act

B Two members from each of the military departments to be assigned by the Secretary of the respective departments after consultation with the Chairman. These members shall normally be of general or flag officer rank and shall be authorized to represent their departments on matters before the Committee.

V Committee staff

A The Committee shall be provided with a staff of military and civilian personnel as approved by the Secretary of Defense.

B The staff shall be headed by an executive secretary who shall be specifically designated by the Chairman This position will normally be occupied by a brigadier general or equivalent and rotated among the three military departments.

C Military personnel shall be detailed to the staff of the Committee by the Office of the Secretary of Defense in approximately equal numbers from each of the three military departments and shall be acceptable to and serve at the pleasure

of the Chairman. During their tenure on the Committee staff, such personnel shall be responsible to the Chairman for the performance of duty. They shall not be transferred or reassigned except after reasonable notice in advance to the Chairman through the Office of the Secretary of Defense so that suitable replacements may be obtained.

D. Civilian personnel for the staff shall be provided by the Office of the Secretary of Defense.

VI. Committee functions and authority

A. The Committee, on behalf of the Department of Defense and in accordance with the provisions of Section 27 of the act, shall advise and consult with the Commission on all atomic energy matters which the Committee, acting for the Department of Defense, deems to relate to military applications of atomic weapons or atomic energy, including the development, manufacture, use and storage of atomic weapons, the allocation of special nuclear material for military research, and the control of information relating to the manufacture or utilization of atomic weapons

B. The Committee shall keep the Secretary of Defense and other appropriate agencies of the Department of Defense fully and currently informed on all matters set forth in VI A above.

C. The Committee, acting for the Department of Defense, shall keep the Commission fully and currently informed on all matters within the Department of Defense which the Commission deems to relate to the development or application of atomic energy.

D. If the Committee at any time concludes that any request, action, proposed action, or failure to act on the part of the Commission is adverse to the responsibilities of the Department of Defense, the Committee shall make such recommendations to the Secretary of Defense as it deems appropriate.

E. The Committee shall be the channel of formal communciation between the Department of Defense and the Atomic Energy Commission, but in the exercise of its liaison function it shall encourage and facilitate informal contacts between agencies of the Department of Defense and the Commission at corresponding levels.

F. In the exercise of the functions and authority prescribed herein the Committee shall not assume the functions and authority of other established agencies of the Department of Defense as provided by appropriate directives.

VII. Procedures

A. The Committee is authorized to establish committees, councils, boards, or assignments as necessary to obtain information and carry out the functions and responsibilities of the Committee.

B. The Committee shall meet at the call of its Chairman or at such times as it may fix, and the presence of the Chairman (or acting Chairman) and three military members, including at least one representative of each department, shall constitute a quorum. Members and Chairman each have equal voting power. If any member dissents on any Committee action, he is authorized to appeal to the Secretary of Defense through the Secretary of the Department he represents. Prior notification of any such action shall be made to the Chairman and other members of the Committee Final action on appealed cases will await decision of the Secretary of Defense.

C. The Committee shall establish its own rules of procedure

C. E. Wilson, *Secretary of Defense.*

October 5, 1954
No. 5148 2

DEPARTMENT OF DEFENSE DIRECTIVE

Subject: Responsibilities of Assistant to the Secretary of Defense (Atomic Energy).

Pursuant to the authority vested in me by the National Security Act of 1947, as amended, and modified by Reorganization Plan No 6 of 1953, a position of Assistant to the Secretary of Defense (Atomic Energy) is hereby reestablished At the discretion of the Secretary of Defense, the Chairman of the Military Liaison Committee may also be appointed to serve as the Assistant to the Secre-

tary (Atomic Energy) without additional compensation. The Assistant to the Secretary (Atomic Energy) shall:

1 Provide the Secretary of Defense and principal members of his staff advice and assistance on atomic energy aspects of Department of Defense policies, plans and programs.

2. Formulate atomic energy policies, plans and programs for the Department of Defense, and monitor compliance with approved policies.

3. Represent or arrange for the representation of the Department of Defense with other governmental, nongovernmental and international organizations on atomic energy matters of mutual interest or responsibility.

4 Formulate policies for the transmission of information to the Joint Committee on Atomic Energy as required by the Atomic Energy Act of 1954, and coordinate such information, where appropriate, with other offices and agencies of the Department and with the Chairman of the Atomic Energy Commission

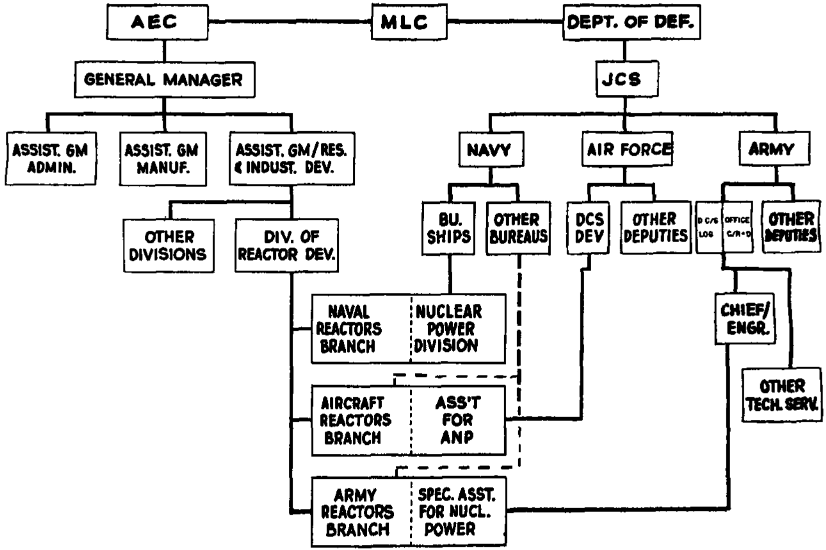
In the performance of these functions the Assistant to the Secretary (Atomic Energy) will by direct access, to the extent necessary and appropriate, utilize the advice, assistance and facilities of the Armed Forces Special Weapons Project, and of other organizations of the Department of Defense (including the three military departments) which are concerned with military application of atomic energy, in lieu of providing for such assistance on his immediate staff, but this arrangement shall not be construed or so utilized as to circumvent the normal command channels through the Secretaries of the military departments for the formal communication of approved policies, plans or other directives.

The Military Liaison Committee, established by the Atomic Energy Act of 1954, shall advise the Assistant to the Secretary of Defense on such atomic energy matters as the latter deems appropriate and necessary.

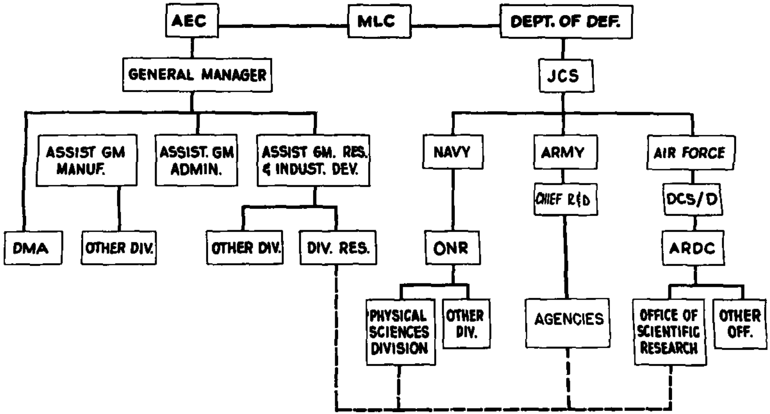
This directive supersedes Department of Defense Directive 5148.2, dated April 13, 1953.

C E. WILSON,
Secretary of Defense.

MILITARY NUCLEAR POWER

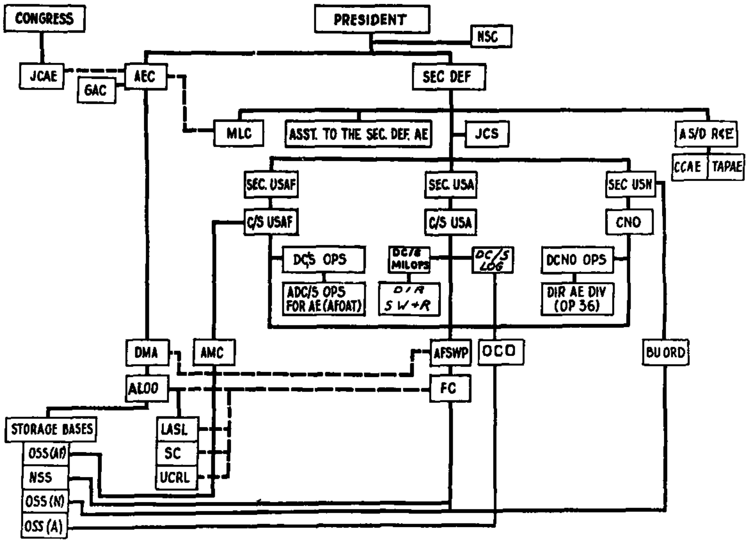


BASIC RESEARCH

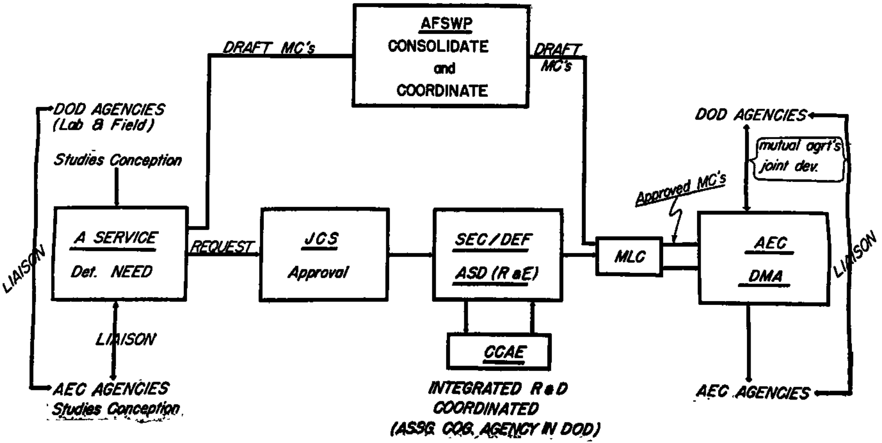


JOINT ONR-AEC NUCLEAR PHYSICS BASIC RESEARCH PROGRAM IS COORDINATED AS SHOWN IN DOTTED LINES ABOVE WITH AEC, NAVY, ARMY, AIR FORCE (ALSO WITH NATIONAL SCIENCE FOUNDATION)

Organization for Military Application of Atomic Energy...



ESTABLISHMENT OF DEVELOPMENT REQUIREMENT AND MILITARY CHARACTERISTICS



The Military Liaison Committee

The Military Liaison Committee, established pursuant to section 27 of the Atomic Energy Act of 1954, consists of a Chairman, appointed by the President as provided for in the act, and two members each from the Departments of the Army, Navy, and Air Force. The Chairman is also Assistant to the Secretary of Defense (Atomic Energy), holding that position at the discretion of the Secretary of Defense. The members, of flag or general officer rank, occupy key positions and have extensive responsibilities in the field of atomic energy within their departments, a fact which is very beneficial to the functioning of the Committee. The members represent their departments on all Committee business. Their assignments are as follows:

Department of the Army:
- Director, Special Weapons, Office of Chief of Research and Development.
- Director, Special Weapons and Requirements, Office of Deputy Chief of Staff for Military Operations.

Department of the Navy:
- Director, Air Warfare Division, Office of Deputy Chief of Naval Operations (Air).
- Director, Atomic Energy Division, Office of Deputy Chief of Naval Operations (Fleet Operations and Readiness).

Department of the Air Force.
- Assistant Deputy Chief of Staff, Development.
- Assistant for Atomic Energy, Office of Deputy Chief of Staff, Operations

Two additional key officials in the field of atomic energy who serve with the Committee in the capacity of observers are the Chief, Armed Forces Special Weapons Project, and the Director, Division of Military Application, Atomic Energy Commission.

The military staff of the Committee, consisting of 12 officers headed by the executive secretary, is located with the headquarters of the Atomic Energy Commission and is organized into five divisions: Administrative, Materials Production, Nuclear Power, Special Projects, and Weapons.

The Committee, on behalf of the Department of Defense and in accordance with the provisions of section 27 of the act, advises and consults with the Commission on all atomic energy matters which the Committee, acting for the Department of Defense, deems to relate to military application of atomic weapons or atomic energy, including the development, manufacture, use and storage of atomic weapons, the allocation of special nuclear material for military research, and the control of information relating to the manufacture or utilization of atomic weapons. With respect to atomic energy matters relating to military application of atomic weapons or atomic energy, the Committee keeps the Secretary of Defense and other appropriate agencies of the DOD fully and currently informed. The Committee, acting for the DOD, also keeps the Commission fully and currently informed on all matters within the Department of Defense which the Commission deems to relate to the development or application of atomic energy.

In accordance with the Department of Defense directive defining the authority and duties of the Military Liaison Committee, the Committee is the channel of formal communication between the DOD and the AEC However, in exercising liaison functions, the Committee encourages and facilitates informal contacts between agencies of the DOD and the Commission at corresponding levels.

THE MILITARY LIAISON COMMITTEE

Members:
- Hon. Herbert B Loper, Chairman
- Maj. Gen. John S. Mills, United States Air Force, Assistant Deputy Chief of Staff, Development, United States Air Force
- Maj. Gen. John P. Daley, United States Army, Director, Special Weapons, Office of the Chief of Research and Development, United States Army
- Maj. Gen. Richard T Coiner, Jr, United States Air Force, Assistant for Atomic Energy, Office of Deputy Chief of Staff, Operations, United States Air Force
- Maj. Gen Dwight E. Beach, United States Army, Director, Special Weapons and Requirements, Office of the Deputy Chief of Staff for Military Operations, United States Army
- Capt. Joseph D. Black, United States Navy, Director, Air Warfare Division, Office of the Chief of Naval Operations, United States Navy
- Capt. Joseph A. Jaap, United States Navy, Director, Atomic Energy Division, Office of the Chief of Naval Operations, United States Navy

Observers
Rear Adm. Edward N. Parker, United States Navy, Chief, Armed Forces Special Weapons Project
Brig. Gen. Alfred D. Starbird, United States Army, Director, Military Application, Atomic Energy Commission

Mr. FULTON. Has the present organizational setup of the Military Liaison Committee worked well in protecting the military programs of the Department of Defense in connection with the Atomic Energy Commission? When we are entering a new field called the space field, which will use many kinds of propellents for space vehicles and missiles, including nuclear and atomic energy, would you recommend the same kind of organizational setup for a military liaison committee to the National Space Agency that we propose by this legislation?

Mr. LOPER. Without making considerably more study of the relationships which may be necessary, I could not recommend it offhand.

I would say if the situations are analogous, then an analogous solution would be a fine one.

Mr. FULTON. Have you read the proposed legislation?

Mr. LOPER. I have read the proposed legislation. I have not had an opportunity to study it and to grasp in my own mind just what the relationship between the space agency and the Department of Defense is intended to be, or would be.

Mr. FULTON. Our problem is the method of setting up the relationships between the Department of Defense and the NASA as proposed, as well as the AEC.

The question is: If the NASA agency that is proposed is to be a civilian agency just as the Atomic Energy Commission has been, then what should the military liaison setup be?

Now, you have had the most experience on that Military Liaison Committee with a similar type of agency in a different field. We, therefore, would like to have inserted in the record, if you are not ready at this time, your considered judgment of, first, how the Military Liaison Committee has acted with the AEC, and, secondly, how it would be set up in conjunction with the current bill that has been entered by Congressman McCormack of Massachusetts.

And, thirdly, I would like to know what your recommendations would be on the Military Liaison Committee in conjunction with an Atomic Energy Commission type setup of five members for the National Space Agency that is proposed.

That is, transposing the successful method which has already been used on atomic energy to the space field.

Mr. LOPER. I will try to answer it in part. I would say that offhand it does not appear to me that the situations are strictly analogous and, therefore, the same solution might not be best.

Certainly, an effective type of liaison between two agencies would be necessary. Whether the same type would be right, I think would depend on the greater refinement of the respective fields of coverage in the production and operation in the research areas.

Mr. FULTON. Would you have the Military Liaison Committee have representatives of the three services, the Army, Navy, and Air Force, as I believe you have now?

Mr. LOPER. I believe this is correct. I believe it would be necessary, each one having certain functions and operations even though they might be of a service nature in the space business.

Mr. FULTON. How big a committee would you have as a military liaison committee to the National Space Agency if it is a commission of five members?

Mr. LOPER. It should not be any larger than we have

Mr. FULTON. How many members?

Mr. LOPER. We have a total of seven, including the Chairman.

Mr. FULTON. Would you again have a military person as chairman of the military liaison committee for the space agency and place that person on the level of the Assistant Secretary of Defense?

Mr. LOPER. I think it ought to be on that level I don't believe it is essential that it be an active military officer.

As you know, the present Atomic Energy Act provides that the Chairman of the Committee may be an active officer of one of the military services, a retired officer or a civilian. We have had all three.

Initially the Chairman was an active military officer for the first couple of years, then we had civilians for a good many years.

I, myself, who went on the job 4 years ago, am a retired military officer. I do not say that one could recommend one over the other.

I think the position in the Department of Defense should be at least that of the Assistant Secretary of Defense level.

Mr. FULTON. Inherent in my question was the possibility that we might in the legislation limit it to an active military person.

Mr. LOPER. A wise move, depending again somewhat on the composition of the space organization.

Mr. FULTON. Generally you would not limit it to that.

Mr. LOPER. I don't believe I would limit it. There is a point of difference here which I think you recognize in considering the organization of the Atomic Energy Commission in that the law does require they maintain a Division of Military Application, which is headed by an active military officer.

Their Division of Military Application Chief is selected from the active ranks of the service.

Mr. FULTON. And he is right under the Atomic Energy Commission?

Mr. LOPER. Yes, sir; his total loyalty is to the Atomic Energy Commission.

Mr. FULTON. Subject to their discretion and control?

Mr. LOPER. Exactly, and subject to their hiring and firing and any time they are not pleased with him, of course, they may relieve him and choose another.

Mr. FULTON. Is his relationship with the Commission a military or civilian connection?

Mr. LOPER. It is civilian.

Mr. FULTON. Is he on inactive duty with the military services?

Mr. LOPER. No, sir; he is just on what you might call a leave of absence. He has no military command or assignment of any kind.

Mr. FULTON. What other military personnel might have been assigned such as he has under him in the Atomic Energy Commission?

Mr. LOPER. He has a military and civilian staff. I would say his local staff in Washington is about half military, who are assigned at their request from military services, and half civilian.

Mr. FULTON. Would you give us the name of the individual currently holding the position, and also the number of civilians and military personnel on the staff?

Mr. LOPER. I do not know the number on his staff. The officer, however, is Brigadier General Starbird, Alfred D. Starbird.

Mr. FULTON. Where is he from?

Mr. LOPER. He is a Corps of Engineers officer in the Army.

Mr. FULTON. Would you at this point in the record put in the organizational setup in general?

Mr. LOPER. Yes, sir; I will give you an organizational chart for the Director of Military Applications.

Mr. FULTON. And also the functions assigned to him by the Atomic Energy Commission.

Mr. LOPER. I shall be glad to do that.

(The information referred to is on p. 847.)

Mr. FULTON. Moving a bit further, the question comes up when we are on dangerous missions such as space flights are to be, should there be special incentive pay for military personnel who undertaken these dangerous missions and missions of peculiar hardship with unknown risks?

Mr. LOPER. I would certainly think so.

Mr. FULTON. Would you recommend to this committee that we enter the fi ·ld or recommend that there be special consideration given on dangerous type military services—possibly where the chances become large on many of these manned vehicles on the original flight, should we not have fifty or one hundred thousand dollars worth of coverage of insurance for the man?

Mr. LOPER. Certainly, some emolument of that type ought to be provided.

This is a tremendous risk, of course.

Mr. FULTON. So that you would recommend that there be separate hazard pay as well as insurance to cover the family for military personnel engaged or lent to this agency for the experimental manned space vehicle flight?

Mr. LOPER. I would certainly recommend that; yes.

Mr. FULTON. Would you rather have a director who is a czar of a program such as the space development, with an advisory committee of 17 members, or would you prefer a setup secondly, that had a 5-man commission organized along the lines of the Atomic Energy Commission?

Mr. LOPER. I would prefer a single director.

Mr. FULTON. How would you set the advisory committee up in that event, and what size should it be, and what powers should it have?

Mr. LOPER. I would not want to suggest what size the advisory committee should be, because I have not tried to visualize the number of interests of a scientific, technical, political, psychological and other nature, which would need some special consideration by an advisory committee.

I think, however, that a committee along the lines of the General Advisory Committee for the Atomic Energy Commission meeting at frequent intervals would be a desirable setup.

Mr. FULTON. Do you think that a voluntary or part-time committee would be adequate in as important a field, where there are so many lines of research to be made as the space field?

Mr. LOPER. I believe there would be.

Mr. FULTON. Would you transpose pretty much the same advisory committee from the NACA?

Mr. LOPER. Yes, sir.

Mr. FULTON. The Advisory Committee for Aeronautics?

Mr. LOPER. Yes.

Mr. FULTON. Would you emphasize people who are currently engaged, either commercially or in the form of military officers, that have had air or aeronautic experience, or would you be more for the scientific and adventurous type of person?

Mr. LOPER. I think you need both for balance.

Mr. FULTON. Then why, if you select a director, should you not look for a balance on a commission such as a man who is knowledgeable on astronomy to begin with, say a man knowledgeable on vehicles and construction; a man knowledgeable on propellents, a man knowledgeable on nuclear atomic power and a man knowledgeable on a public approach with some financial and business background?

Why could you not, while looking around for people of specific talent combine them in a better working organization in a combination of five, than you would have if you had a director or czar. Then you would have to decide whether he was a businessman, officeholder, military man, scientist, or administrator?

Mr. LOPER. My general opposition to commissions as directors of active programs is that individually they cannot keep their fingers out of the operating end of it, if they are full time.

If they know everything that is going on down to a lot of the field operating details, they are inclined to attempt to make those directly rather than through the man they have hired for the job.

Mr. FULTON. Suppose a commission of five should set up an office of director, or Congress set up an office of director which was approved by the Senate, would that assist you in getting some sort of modified type of organization—one that would combine both the features of a director and the commission such as the Atomic Energy Commission?

Mr. LOPER. This might be useful. Under the present Atomic Energy Act the General Manager has certain functions which may be delegated to him by law. The law permits certain functions to be delegated to the General Manager.

It is silent on other functions, leaving the Commission to decide what other functions they may delegate or they wish to delegate, and also whether they wish to delegate those functions which the law forces them to do. The result is that some functions are delegated to the General Manager to perform without direct instructions. Many others are not.

It has been my experience that this variation in delegating authorities to an operating manager leaves him at a total loss as to how to proceed. He can proceed on somewhat minor things which may be delegated to him in a day-to-day operation and find himself running crosswise with one or more of his Commissioners.

Mr. FULTON. Will you put in the record at this point your ideas on these functions of various suggestions which I have made, so that we will not go into them in too much detail here?

Mr. LOPER. Yes, sir.

(The material referred to follows:)

DEPARTMENT OF DEFENSE,
MILITARY LIAISON COMMITTEE,
Washington, D. C, May 13, 1958.

DEAR MR. CHAIRMAN: In response to a committee request during the hearing of April 28, 1958, I am forwarding my personal views concerning the commission-

type organization However, I suggest that the Atomic Energy Commission itself might be a better source of information concerning the details of operation under this form of organization.

It is my feeling that an operating program can be far more effectively managed and directed by a single manager or director than by a commission. Scientific advice and guidance is desirable, of course, and may be furnished by a committee similar to the General Advisory Committee to the Atomic Energy Commission. However, the decision making authority and the responsibility for execution of a program should be lodged in an individual In the commission form of organization, the day-to-day operation becomes cumbersome It is difficult to reach timely decisions and responsibility for successful and efficient operation may be divided. The manager, who must operate under whatever authority has been delegated to him by the commission, may frequently be hampered by having to wait for commission deliberations and decisions

Sincerely yours,

HERBERT B. LOPER, *Chairman.*

Mr. FULTON. Lastly, I want to ask you· Do you favor more the Manhattan-type project with a General Groves in charge than the development of an Atomic Energy Commission as a civilian agency, as it historically developed?

Mr. LOPER. No; for the purpose for which it was established, which was a wartime crash program for the development of atomic energy for a specific purpose, I believe the Manhattan project was a superior type of organization. When it entered into broader fields, then I think civilian control was quite the proper thing to do.

Mr. FULTON. As this Agency is now proposed, it is to enter into the broader field, so you would then recommend a civilian-type agency.

Mr. LOPER. Yes; but my question is whether this civilian-type agency should be headed by a Director and with the general supervision of a board of directors, headed by a chairman, or whether it should be an operating agency under the direct operation of a commission.

My feeling is that it should be the former.

Mr. FULTON. Would you have it as an advisory or as an operating group?

Mr. LOPER. I think it can be more than advisory. I think that it could establish certain basic policies.

An advisory committee formula does not have the function of really establishing policies It is only when they come to the actual implementation of policies which have been established that I find the commission-type of control to be at least cumbersome

Mr FULTON But you would have this particular National Space Agency set under Congress' supervision and operate the national policy for space, would you not?

Mr. LOPER That is right.

Mr. FULTON Secondly, then, in the operations you would have the new Columbus of 1958 start out, directed, controlled, and operated by the National Space Agency, would you not?

Mr. LOPER Yes, sir.

When one speaks of operation, though, directly controlled and operated, to me that implies that they take part in the day-by-day management of the business.

Now, this is the part that I find to be cumbersome from a commission operation standpoint.

Mr. FULTON. Do you feel, at present, there should be a large expansion of the space research exploration, development of missile and vehicle programs?

Mr. LOPER. I do not believe there should be a large expansion until there are large numbers of ideas and areas which show promise of exploration, of fruitful exploration.

I do not believe in expansion just for expansion's sake, but where there are large numbers of apparently, or possibly advantageous areas that we should look into, then certainly an agency should be available to do this.

Mr. FULTON. My last question is this:

You would favor von Braun's 150-mile shot of man in space; would you not? And you would not consider that like shooting a woman out of a cannon?

Mr. LOPER. No, sir; not at all

Mr. FULTON. What do you consider it?

Mr. LOPER. Frankly, I do not see much merit shooting a man 150 miles into space just to shoot a man into space 150 miles.

Mr. FULTON. Is that program worthwhile? That is a very disputed question before this committee. What would you say about it?

The CHAIRMAN. Von Braun did not say he was just shooting a man into space. He said he would be up there 5 or 6 minutes and would supply information that is available.

Mr. LOPER That is right. If it is a step in the right direction, and I assume it has been thought out by Dr. von Braun, a step in the direction of the useful navigation of space, and a necessary step in that direction, then it is the right thing to do.

Mr. FULTON. He thought it should be, but there were some scientists who felt it should not be.

Thank you; that is all.

The CHAIRMAN. Mr. McDonough, do you have some questions?

Mr. MCDONOUGH. In reference to this question of shooting a man into space, there has been much ridiculous talk about it. Personally, I think it would reveal a lot of scientific information we do not have.

The CHAIRMAN. I might say that the gentleman is here for a limited purpose in connection with the organization

Mr. MCDONOUGH. Yes; but I want to consider the matter. It may reveal a great deal of information concerning the effect on man, the reentry problems of heat and landing and the ability actually to project a man a distance into space.

Do you now agree that that would be necessary information for us to have?

Mr. LOPER. If we are contemplating, as I am sure we are contemplating, some type of outer space travel by humans, then, of course, it has to be approached step by step to determine just the thing that you have mentioned, sir.

As I say, if Dr. von Braun's proposition is an essential step on that road, then it is the proper thing to do.

Mr. MCDONOUGH. In your connection with the Atomic Energy Commission, are you there for the purpose of liaison of the Defense Department for military observation, or for any civilian development that they may reveal in their investigations?

Mr. LOPER. Well, there is a close tie-in between civilian military applications, particularly in reactors for propulsion versus reactors for stationary power.

In the medical and biological areas, what applies to civilians also applies to military. So as a Military Liaison Committee we do keep

ourselves acquainted with their civilian-type projects to determine what interest they are to us, what is being learned from them, and how they may be applied to Defense Department business.

Mr. McDonough. Do you envisage this Agency that we are considering here in this bill as more in the interest of civilian than military development?

Mr. Loper. It would appear to me that at least for a good many years its interest will be primarily in military development, because this is where we are now, and the space business is primarily for determining the value of movement in or the occupation of space for military purposes.

In the long run it is difficult for me to say. I could not project myself into the future far enough to say whether these interests will be more in the military line or more in the civilian or peaceful line.

I would certainly hope that it would be more in the civilian applications.

The Chairman. That depends a lot on world conditions?

Mr. Loper. Yes, sir. This depends on things outside our ken at the moment.

Mr. McDonough. In other words, as we develop military uses of outer space and travel and communications, the byproduct of that for civilian development will come as a natural consequence.

Mr Loper. It has always happened this way, of course; many developments which we have undertaken on an urgent basis for military purposes have broadened themselves into civilian applications.

Mr. McDonough. Do you think the Agency should be limited in its operating authority to basic research or should it go beyond that?

Mr. Loper. I have not studied that part. As a matter of fact, I have given very little thought to that because I am extremely busy on other things, and space matters do not come into my field except as it touches on the business between the military department and the Atomic Energy Commission, on which I effect liaison.

Some place in the civilian aspects of this there must be space for more than just basic research, it seems to me. Therefore, if you have a Space Agency as a civilian organization, its functions, to my mind, should not be limited to basic research.

The Chairman. Mr. Keating.

Mr. Keating. General Loper, I realize you were called here for a specific purpose to discuss this Military Liaison Committee, but you have been asked a lot of other questions and there is one matter among those that I want to clear up

This recommendation you made for more pay for the military involved in space work, does that have clearance from the Department of Defense?

Mr. Loper. Not at all.

Mr. Keating. You are only speaking as an individual?

Mr. Loper. I am speaking entirely as an individual giving an opinion that if you want to get useful work out of people of this type, you had better pay them well for it whether they be civilians or military people.

Mr. Keating. You have in the Department of Defense others engaged in hazardous work who do not get extra pay now?

Mr. Loper. I think that is right. There is some hazardous pay being paid, but you have a great many people who do not get it.

Mr. KEATING. When you enlarge the activity of those who are to get extra pay you run into competition always in the Department of Defense?

Mr. LOPER. That is right.

Mr. KEATING. I would not want to have it appear here that your recommendation was a Department of Defense recommendation.

Mr. LOPER. Clearly not.

Mr. KEATING. With regard to the Military Liaison Committee this was set up in the Atomic Energy Act of 1954.

Mr. LOPER. Yes, sir; initially in the first Atomic Energy Act of 1946.

Mr. KEATING. Did the act of 1946 have the same setup as the 1954 act?

Mr. LOPER. Yes, sir.

Mr. KEATING. In other words, the section 27 that you have put in the record here from the act of 1954 was practically verbatim in the 1946 act?

Mr. LOPER. It is about the same. There have been some changes in the wording, but no changes in the actual functions.

Mr. KEATING. One of our problems here is whether to set up some liaison arrangement in the act in detail, or to leave it to general language. We all agree there should be liaison between military and civilian.

Do you have any views as to whether it is better to set up general language and leave it to the administrators of the Defense Department, or Space Agency, to work out details, or set up the details of that Military Liaison Committee in the law at the outset.

Mr. LOPER. I believe there should be general language.

The CHAIRMAN. Suppose he does not do it that way. It is discretionary. Suppose he decides to appoint a liaison committee.

Mr. LOPER. I would not make it discretionary.

Mr. KEATING. You say there shall be liaison between the two, but more or less leave it to them to set up the method of liaison?

Mr. LOPER. Yes, sir.

Mr. KEATING That is all, Mr. Chairman.

Mr. FULTON. May I ask another question?

The CHAIRMAN. Yes, Mr. Fulton.

Mr. FULTON. Your views here as a witness are those that have come to you as you sit in a rather informal discussion, and you have not limited yourself solely to views which have previously been cleared by the Department of Defense and the Atomic Energy Commission?

Mr. LOPER. This is correct. These are my personal views, speaking entirely and trying to be as helpful as I can to this committee, in considering this very important question.

Mr. FULTON. I might say my questions were not intended to bind you on your views, but to explore how we might better set up a program.

The CHAIRMAN. Mr. Secretary, how has the Liaison Committee setup in the AEC worked?

Mr. LOPER. I think it has worked very well. I do not want to give myself any plaudits on this as Chairman of it, but I believe the concept and the operation of the Committee has been entirely satisfactory.

The CHAIRMAN. In an activity where there is dual responsibility, one civilian and the other military, where the exigencies of the military cannot be ignored, but must be given proper emphasis, such a committee might in operation obviate rigidity in the law and try to set forth in detail what their functions would be. It would allow more flexibility.

Mr. LOPER. Yes, sir; this is right Initially I said if the situations are analogous, then the solution should be approximately the same.

I just do not quite see that we have an analogous situation, therefore, I make no specific recommendation as to whether one should have or should not have a military liaison committee.

In the relationship between the Atomic Energy Commission and the Department of Defense, one must keep in mind that the Atomic Energy Commission does perform a specific military function in that it designs and builds weapons for the Department of Defense. It does not do it as a contractor to the Department of Defense, but as a separate Government entity or agency—this making it, I think, quite appropriate that a formal liaison be established, as well as the somewhat peculiar organization of the Commission in having a Director of Military Applications assigned to it from the military services.

It is not apparent to me from what I have heard heretofore of the proposed act that the same situation necessarily exists between the Space Agency and the Department of Defense in this subject.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. In response to a question put to you by Congressman Keating, you said you would prefer general language to be used in connection with describing the duties of a liaison committee.

Would you say that language similar to the language contained in the Atomic Energy Act of 1954 was general in character?

Mr. LOPER. I think that is general language because our own directives go much further than this in the actual organization.

Mr. FELDMAN. That is what you had in mind when you answered his question; is that right?

Mr. LOPER. That is right.

Mr. KEATING. Would you yield at that point?

Mr. FELDMAN. Yes.

Mr. KEATING. That clearly was not my understanding of your answer, General Loper. I put to you this question:

Should we just say there shall be liaison and you said you favored something along that line. This section 27 sets up the method of effecting that liaison, does it not?

Mr. LOPER In part, it does; it gives the broad functions of the Committee which I believe should be specified in the law.

Mr. KEATING. I thought you were not prepared to recommend whether there should be a committee?

Mr. LOPER. Well, if there is a committee——

Mr KEATING. Whether or not there is a committee there has to be liaison, has there not?

Mr. LOPER. That is right.

Mr. KEATING. So you do not know whether there should be a committee?

Mr. LOPER. That is correct. I do not know whether there should be.

Mr. KEATING. If there is not a committee, then this language would not be appropriate?

Mr. LOPER. That is right.

Mr. KEATING. Then we have to decide if there must be such a committee before you would say this language was appropriate?

Mr. LOPER. My point is this: if you do have a committee, the functions of the Committee should be specified in the law and thus become binding on both agencies, not to be decided by arrangement between them.

When I said it should not be on detail, I had in mind how it is organized and operates.

For example, I do not think it is necessary to specify that there shall be two members from each of the services. This I think is a detail which could be left out.

Mr. KEATING. It says representatives from each of the Departments of the Army, Air Force, and Navy in equal numbers should be appointed by the Secretary of Defense in this work.

Mr. LOPER. That is right. When I agreed with the counsel it should be along the lines of section 27 of the act of 1954, I had in mind not that it specified actual membership, but know how it performs its functions.

The CHAIRMAN. You might say there shall be three representatives, but not designating what services they came from, leaving it to the Secretary of Defense.

Mr. LOPER. I think that would be a reasonable thing to do, sir.

Mr. KEATING. You believe we first must decide that such a military liaison committee is necessary in the Department of Defense rather than in the Space Agency before we can set up anything like this provision in the Atomic Energy Act?

Mr. LOPER. Yes, sir; I think the first decision is whether the relationship between the two is such as to require a formal statutory liaison.

Mr. KEATING. On that you have no opinion?

Mr. LOPER. I have no opinion on this.

Mr. KEATING. Certainly unless we have a firm opinion, it would be better for this committee to provide in general there shall be liaison between military and civilian.

Mr. LOPER. That is right. If the committee is undecided as to the importance of it, that is all.

The CHAIRMAN. You do say the Liaison Committee has worked effectively with the AEC?

Mr. LOPER. That is right.

The CHAIRMAN. As I understood you, you said the Liaison Committee would be important in connection with this new agency.

Mr. LOPER. Liaison is very important. Whether it should be a formal committee or established as between the two——

The CHAIRMAN. If we provided nothing it would be wise for the Director and the Defense Department to appoint one administratively.

Mr. LOPER. Yes.

Mr. FELDMAN. I understood you to say, General Loper, in response to a question by Congressman McDonough, that the primary emphasis of the new agency would be military in character because of the overlapping of many of the problems; is that right?

Mr. LOPER. I would say initially it would appear to me to be so.

Mr. FELDMAN. And it would probably continue for several years?

Mr. LOPER. I would think so.

Mr FELDMAN. So that liaison between the military and this new Space Agency would be very important; is that right, General Loper?

Mr. LOPER. It would be very important.

Again it depends on a very careful definition of what the functions are of each of the organizations.

Mr. FELDMAN. Could you describe, in as much detail as you can, how your liaison committee functions, starting with the policy board on top and how it seeps through the organization down to the low echelons?

Mr. LOPER. There are, perhaps, two main fields of interest There are a great many minor fields of interest The two major fields of interest are the study, design, development, and production of nuclear weapons, and, secondly, the development of nuclear power for military purposes.

Now, the concept of a military application may begin anywhere, as anyone knows. It may begin in the minds of a laboratory technician, or it may begin in the mind of a military officer or military group.

When this concept is developed to the point where a study needs to be made as to whether it is really technically feasible, we have our first formal communication on this subject between the Department of Defense and the Atomic Energy Commission.

This communication emanates from one of the services which has a major interest in a particular study. It will go to our Assistant Secretary of Defense for Research and Engineering, who will decide whether or not it appears to have sufficient merit to justify investigation If he thinks so, he then asks the Military Liaison Committee to see that such a study is initiated, and the Military Liaison Committee does set up this study as between the Atomic Energy Commission and the appropriate agencies of the Department of Defense.

A study will be reported out, favorably or unfavorably, either that this proposed development of a new weapon or a new application is sound or it is not

If it is decided that it is sound, then the Military Liaison Committee refers it back to the Atomic Energy Commission to develop the nuclear part of the proposed application, and to the appropriate service for development of the carrying or delivery system.

This has to do particularly with the weapon. If it is a reactor, it is the same way. It goes back to the Navy, Army, or Air Force for development of the nonnuclear parts of the system we are talking about.

This is the way in which we get our business started.

Mr. McDONOUGH. Will you yield at that point?

Mr. FELDMAN. Yes.

Mr. McDONOUGH. General Loper, would you authorize this Agency to enter into a licensing agreement with private industry for the development of some experiment into outer space, in the building of satellite spaceships, or the shooting of satellites?

Mr. LOPER. The particular arrangement that it makes with private industry would appear to be a matter of judgment. Whether it be by contract or by license or some other arrangement, I would not want to express a view without looking at the particular problem.

Mr. McDONOUGH. I mean in general, like the Atomic Energy Commission does at the present time?

Mr. LOPER. Yes, sir. They perform a great deal of work by contract or by an operational organization, such as General Electric, which operates their Hanford program, and so on. By license or by contract, or otherwise, does not appear, to me, to offer any difficulties?

Mr. FELDMAN. Is the liaison continuous or spasmodic?

Mr. LOPER. The liaison is continuous. We have a permanent military-liaison staff which lives with the headquarters of the Atomic Energy Commission, has day-to-day contact with various of its divisions. We have a permanent field organization which does not report directly to the Military Liaison Committee, but which is our agency for the preparation of technical reports, for working closely with all of the laboratories and the storage-site people.

This is the Armed Forces special-weapons project that you will see referred to on one of the charts here. It is established for this technical liaison, lower level liaison purpose, and it maintains its personnel at laboratories and other activities of the Commission where day-by-day technical-level liaison is necessary.

Mr. FELDMAN. For this liaison to function efficiently, it has to be continuous and work from day to day?

Mr. LOPER. That is right.

Mr. FELDMAN. I believe you testified not only as to broad policy which is established by your Committee, but, also, that which seeps down through the organization so that you keep a constant flow of information and liaison between the lower groups?

Mr. LOPER. That is correct.

Mr. FELDMAN. The purpose of the liaison is so that the right hand knows what the left hand is doing; is that not so?

Mr. LOPER. Yes, sir.

Mr. FELDMAN. Can a liaison work effectively if it just works spasmodically, say once a month, or six times a year?

Mr. LOPER. Not at all

Mr. FELDMAN. I have one last question. Since we have had testimony before this committee indicating that the new NASA might be primarily military in character, and, further, because of your response to Congressman McDonough about the military nature of the new Agency—why call it a civilian agency if it is to be military in character?

Mr. LOPER. Well, we have good basis for it. The work of the Atomic Energy Commission, I think one could say, over the past 12 years, has been at least 75 percent military work, yet we call it a civilian agency, and it is. So, I do not think the amount of work one does in one line or the other determines whether it should be civilian or military.

Mr. FELDMAN. Is there not a similarity between the atomic-energy setup and the new Agency? NACA primarily is engaged in military work. The new Agency will continue that work. The Atomic Energy Commission took over the Manhattan project, which was military in character, and has continued on, in a so-called civilian way, the work which had been started there. Is that not so?

Mr. LOPER. That is right; yes.

Mr. FELDMAN. Is it your opinion that the AEC setup is a successful one?

Mr. LOPER. Yes, sir.

Mr. FELDMAN. I suppose I should ask you the obvious question: Why not use the same pattern, since it has been a successful standard of measurement?

Mr. LOPER. I see no reason why one should not use the same pattern—that is, a civilian agency, to direct the broad policy dealing with the development of utilization of space. I am not saying the organization could not be improved for so doing. As I indicated, I believe a single director rather than a commission form, in my personal opinion, is a better way to get at it.

I certainly have no quarrel with the administration's view that this should be a civilian setup. Getting down to my particular area here, which is the liaison area, I would not, until I could see the work which each is to perform, I could not recommend to myself or anyone else whether anyone did or did not set up this type of liaison.

The CHAIRMAN. It says that this new Agency shall exercise control over aeronautical and space research and so forth, except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations. I recognize the importance of the military in the world today, at all times, but particularly today. Yet, under that language, would it not give the Defense Department a complete voice in determining to what extent the new civilian agency might operate? According to what you and others say, practically everything is peculiar to or primarily associated with weapons systems of our military operations today.

Mr. LOPER. I do not think so when you read herein—

in which case the Agency may act in cooperation with, or on behalf of, the Department of Defense.

The CHAIRMAN. Again, that is language where the Department of Defense permits them.

Mr. LOPER. We had some similar language in the Atomic Energy Act of 1954. We have had no difficulty with it at all. They have the primary voice in the development of nuclear weapons and in their production, and yet they offer no difficulties in dealing on an appropriate and equitable level of interest here

I think all you are trying to do with this language is to point out that, in those things dealing with military applications, the Department of Defense is the agency of primary interest. This seems to me, offhand, to be appropriate.

The CHAIRMAN. That word "except" is what attracts my attention. You say we give this new Agency broad powers.

Through the word "except" you take all the powers away from it practically unless the Defense Department says it is all right. It seems to me that that word "except" is very significant.

You could say this:

Insofar as such activities may be peculiar to, or primarily associated with, weapons, the agency may act in cooperation with, or on behalf of, the Department of Defense.

If words could be put in there it might take care of it, but I am concerned about the word "except."

Mr. KEATING. A school of thought has developed that because the present activities of space are more largely of military character than they are civilian, there is no need of a civilian agency here. You do not share that view, do you, General Loper?

Mr. LOPER. No, sir.

Mr. KEATING. You do not blame us for looking forward to the day when we can forget about the military applications of outer space and look forward only to the peaceful applications.

Mr. LOPER. Not at all.

Mr. KEATING. You recognize that those peaceful applications might, as in the case of the atomic energy, someday completely overshadow and exceed those military uses to which we have put those forces.

Mr. LOPER. I fervently join you in the hope that we can look forward with some confidence to exactly this.

The CHAIRMAN. That is only a hope for the time being?

Mr. LOPER. That is only a hope for the time being.

The CHAIRMAN. I think we understand the significance of your testimony and your state of mind, General Loper. I do not think there is much difference of opinion between you and the members of the committee as far as that goes.

Mr. LOPER. I am sure not. I just regret I have not been able to give this subject a great deal of attention, not being in my particular line of business. So I am speaking only of what comes out of a mind here based on a few years of experience in similar work.

The CHAIRMAN. Mr. Feldman wants to ask another question, sir.

Mr. FELDMAN. How do you envisage the relationship will be between atomic energy and outer space?

Mr. LOPER. Atomic energy we think has a very important contribution to make to propulsion systems which might be quite useful in outer space or power supplies for long voyages in outer space and certainly it has a very vital function to perform in that area.

Mr. FELDMAN. How would you draw a line between them?

Mr. LOPER. What right now, it seems to me, would be useful for outer space travel in the nuclear power area would be quite useful for military purposes.

In other words, at the present time from the military standpoint we are interested in the use of nuclear power for a good many things within and without the atmosphere.

Mr. FELDMAN. How would you draw that line?

Mr. LOPER. At the moment I do not see how one can draw that line.

The CHAIRMAN. That is where the liaison committee might come into effective operation; is that right?

Mr. LOPER. That is right.

What is useful, let us say, to propel something for peaceful purposes in outer space might be quite useful to propel the same thing or similar thing for military purposes in outer space.

So I do not think one can distinguish here.

Mr. FELDMAN. Earlier in your testimony you mentioned something about the Commissioners mixing in the operation of the Liaison Committee.

Mr. LOPER. No; not in the operation of the Military Liaison Committee. I was saying that the commission forms of control, in general, run into the problem of individual commissioners getting concerned with day-by-day operations, thus directly obstructing or slowing them up. This is particularly troublesome when one takes a reasonably routine or minor problem and you have to set it before the Commission and obtain a majority ruling on it, which obviously slows down business when one man could have said go ahead, or don't go ahead, as the case may be.

Mr. FELDMAN. Of course, that is a question of organization.

We have heard, for example, of people in business who take care of details—and the big problems take care of themselves; is that right?

Mr. LOPER. That is right. It is a matter of rare judgment required in deciding to what extent the director of an organization might proceed to do business.

The CHAIRMAN. Are there any further questions of General Loper?

For myself, as chairman of the committee, and for other members of the committee, I express our thanks.

Mr. LOPER. It is a great pleasure to be here, Mr. Chairman.

The CHAIRMAN. The next witness whom we are very glad to have appear before us to give us the benefit of his views, is Dr. James A. Van Allen, professor of physics, State University of Iowa.

Dr. Van Allen, we are very glad to have you appear before us. You may proceed.

STATEMENT OF DR. JAMES A. VAN ALLEN,[23] PROFESSOR OF PHYSICS, STATE UNIVERSITY OF IOWA, IOWA CITY, IOWA

Dr. VAN ALLEN. I have made a brief prepared statement, Mr. Chairman, which I believe has been distributed to the members of the committee.

By way of identification, I should say what my general interest and background in this area is so that you may know from what experience my point of view stems. I have been working in the field of high-altitude research with rockets for about 12 years now since the beginning of the subject in the United States.

Recently I have been specially concerned with the scientific measurements which can be made by satellites and it is in my laboratory that much of the apparatus was built which is presently being carried around the earth by Explorers I and III.

I may say I have a fairly sharp difference of opinion with General Loper on the primary purposes of outer space research.

I feel that the purposes are in the following order: First, there is the basic investigation of geophysical and astrophysical phenomena. We must realize that there is a vast area of ignorance about what is going on around the earth from the standpoint of physical phenomena. It is in this field that we have been working for 12 years using vertically fired rockets and it is in this field that the emphasis of satellite work has been up to the present time.

In the second place, it is clear already that there will be substantial civilian applications of outer space vehicles I may mention 1 or 2 of those as primary examples.

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One example is in the study of weather on a worldwide scale and in the reliable prediction of weather. The civilian applications of such predictions are vastly more important than the military ones

As a second example, there is the clear prospect for a great improvement in high speed radio communications on a worldwide scale by the use of satellites. I believe that these developments likewise will be of much greater benefit to the citizenry at large than to military operations alone.

In the third place there is the purpose of space development which I have called the field of human adventure and exploration. I think this is the field which Dr. von Braun has emphasized before this committee.

I have no special comments to make on that I think it is not a hard-boiled, immediate need of the country, but it is certainly a natural field for human activity and will very likely be an important one in the long run.

Fourth, I would list the development of military applications as a field of importance, but, in my opinion, one of less importance than the civilian possibilities for the benefit of fundamental understanding, for the benefit of agriculture, and for the benefit of the citizenry at large.

I think that in many discussions of outer space, the cart is very much before the horse. Those of us actually working in this field clearly recognize the great ignorance which exists with respect to what is going on outside the earth. In my opinion this must be our first and most important concern for the next few years, the obtaining of basic knowledge about what is happening. The applications must follow knowledge—because if one does not know what is going on, he certainly does not know what to do with it.

I have the strong feeling that the Department of Agriculture, for example, might have more cognizance and basic interest in the research in outer space than Defense, actually.

The principal part of our space program in the United States has been during the past 12 years, beginning in 1946, the use of vertically fired rockets for exploration up to about 200 miles. This field will naturally and necessarily continue to be a rather large area in outer space research. I think one must not jump over all the "here and now" techniques used in physical science to the dreams of distant space voyages such as whistling around the planet Venus on an ion beam. We have a great deal of "here and now" technology in vertically fired rockets which is by no means fully exploited. Satellites are, however, greatly superior vehicles for doing certain types of scientific measurements in the vicinity of the earth. I have a very keen appreciation of this point, personally, because I have been working for about 12 years in measuring the radiation intensity at high altitudes above the earth by means of rockets. But in the data already received from Explorers I and III we have enough measurements to supplant, I should estimate, several hundred years of work by our previous techniques. So there is, in many areas, a very great increase in effectiveness which a satellite makes possible in many scientific areas.

I should like to enter the following summary statement, which is in my written statement, that I feel our national space program in the immediate future should emphasize the thoroughgoing investigation of physical conditions pertaining to the earth. This is my feeling

as to its most essential and hard-boiled immediate future. It is reasonable to expect that there will be quite substantial applications.

I mentioned two of them; the study of the motion of air and cloud cover and of hurricanes above the earth, and the general field of weather prediction which I think must be and should be regarded as primarily a matter of civilian welfare; and, second is the one having to do with the conduct of high speed radio communications on a worldwide basis. Here again, although there are undeniable military possibilities. I think that the primary concern is a civilian one.

In the field of human exploration and adventure, there are many enthusiasts for flying men in space vehicles. It has been a fascinating field of human speculation. I feel somehow that we must do so in due time. Before we do it, however, there is a great deal of preparation required. There need to be flights of simple biological specimens. There need to be progressively, flights of animals of progressively greater complexity, approaching that of man. I feel that before we can prudently place a man in space, there must be a very substantial period of preparation.

On the subject of military applications, I think many of these things which I classify as primarily civilian applications are of military importance as well.

I think one can break down the subject something like this; there is certainly a very strong and immediate military need for being able to hurl, a 1-ton object 5,000 miles, and I think no one can dispute the fact that doing so is clearly a military undertaking. But when one speaks of placing scientific apparatus in an orbit about the moon, I feel that this is much more clearly a purely scientific undertaking at this stage, and that is military importance is very difficult, if not impossible, to demonstrate to a critical person.

Now, I understand I am to speak specifically with respect to the pending bill, H. R. 11964 (identical to H. R. 11881). As a general statement, I strongly support the language and intent of this bill.

I may say that there was a bill introduced by Representative Coad, of Iowa, H. R. 9966, early in January. I personally prefer Mr. Coad's bill in a number of detailed respects although the basic intent is similar to that of H. R. 11964.

Now in accordance with the spirit of 11964, I would like to emphasize the fact that I feel that civilian management of a space program is a very vital matter, and, as a matter of national policy, I strongly urge that there be such civilian management.

The essential issue, of course, is who has primary cognizance over space among all Government agencies. I feel the language of this bill should be strengthened substantially to make it clear that the NASA will have primary and dominant cognizance of space matters among all Government agencies, and that only in case it is clearly demonstrated that an endeavor has a direct importance to our military preparedness, a direct importance, a direct and short-term importance, such as intercontinental ballistic missiles, should the primary cognizance reside in the Defense Department. The Defense Department has vast facilities which will be quite useful in any space endeavor—use of ships, proving grounds, and so forth. At the same time, the Military Establishment will profit by space research. But I feel that the primary cognizance should rest with the proposed civilian agency, the NASA. But no matter how well written the

legislation we have available as enabling legislation for NASA, the real crux of the matter is how it is funded, because without that its creation is a hollow gesture.

As a matter of estimation of what is required, I would submit the following remarks:

Our present IGY national satellite program is reliably estimated to be costing us about $150 million. As you all know, this is a very small start in the undertaking of exploring and utilizing outer space. So I think it is clear that something of the order of $500 million a year will be required for a vigorous national space program.

There is also the issue of how to go about actuating the NASA. I have a few remarks on that:

I think it has already been included in the bill that the proposed Space Agency would immediately encompass all the present activities, facilities, and personnel of the NACA.

In addition to that, it appears to me to be vital that all activities of other Government agencies, which are principally concerned with space endeavors, also be transferred to the administration and supervision of the NASA as rapidly as this can be done. There are many agencies with which I am personally familiar which can be transfered readily to the new NASA.

The CHAIRMAN. You notice there is a provision in the bill authorizing, under certain conditions and within a period of 3 years, the transfer of other agencies and functions to the new Agency?

Dr. VAN ALLEN. Yes, sir. I favor that, although I think the time scale implied is rather longer than I should like to see. Three years is a long time in this game.

The CHAIRMAN. They do not have to wait 3 years.

Dr. VAN ALLEN. That is right.

The CHAIRMAN. I notice the Coad bill prefers the commission form of agency rather than director.

Do you favor that?

Dr. VAN ALLEN. Yes, sir; although I think that General Loper is much better able to speak from personal experience. However, I have had some experience with the Atomic Energy Commission's operations, and I think that, as in that field, the field of space research is a very diverse one. There are many aspects: Astrophysics, astronomy, geophysics, biology, medicine; there is propulsion, guidance, communication, telemetry. It is quite a vast technical field.

I feel that a greater diversity of policymaking talent is required than would likely be possessed by any single person as a director. I realize that there is inevitably a certain amount of pulling and hauling that will go on among five different persons, but I think that is just the pulling and hauling one needs to come up with a balanced national program in the space field.

So I do favor the commission idea as represented in Mr. Coad's bill.

That is a summary, Mr. Chairman, of my feelings about the principal points.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Dr. Van Allen, I am glad to hear you say that you strongly support the language and the intent of the present bill before the committee.

As you know, the President and others have thought that now is the time to set up a new agency and it was important that a National

Aeronautics and Space Agency be created and brought into use at this time.

The members of this committee, Dr. Van Allen, have certain ideas on the type of agency we should have. There are other Members of the House, as you probably know, who may not agree that a new agency is required at this time.

The question will arise on the floor of the House at the time this bill is presented as to why we need a new agency. We have the National Science Foundation, we have the National Advisory Commission for Aeronautics, and we have the Atomic Energy Commission, and so on down the line. They will all be enumerated.

The bill before us, H. R 11881, which was introduced by our chairman, Mr. McCormack, sets forth, under the declaration of policy, some of the reasons why we need a space agency at the present time.

I read a statement this past week, Dr. Van Allen, that I would like to read into the record, and I want to see if you agree with it.

The statement is as follows:

> The vital point is not so much that the Soviet satellite preceded that of the United States, heretofore credited as the leader of world technology. It is that the United States for the first time finds a challenging competitor in the most advanced scientific fields.
>
> What most Americans did not know is that we are in a desperate race for control of man's mind, an intellectual race which is brought to light by the Russian sputnik and the complacency of our assumed technological lead.
>
> We have confused our high standards of living and material prosperity with intellectual stature. It is an extravagant and dangerous mistake.
>
> The race for intellectual preeminence has as its objective the creation of a new instrument of national policy to supplement the traditional instruments of military power and of national wealth.
>
> The instruments of foreign policy before the satellites were launched were physical strength, productive capacity, and national wealth.

Dr. Van Allen, do you agree in substance that that statement is correct?

Dr VAN ALLEN. I have a very deep sympathy with those views. In fact, as one whose primary interest is in teaching, I see this every day.

I think it is quite easy to visualize, if we don't get cracking on this field, that my young son, for example, will want to go to Russia to study physics. By the time that he is of college age, it may well be that this is the best place to do so. I think that we are strongly in danger of loosing intellectual leadership. Before and even after World War I, everyone who wished to study advanced science and medicine went to Europe. If one wished to study science, he went to Germany. If one wished to study medicine, he went to Vienna. It could easily happen that 10 years from now a bright young man in the United States would be well advised to go to Moscow to study physics. I would bitterly regret that.

I think we will become a second-rate nation if we do not support our best talent in basic research and intellectual endeavor.

Mr. NATCHER. Assuming that you were a Member of the House and had to present this bill to the membership for action, and the question were asked you as to why we need a new agency, at the present time, entitled "The National Aeronautics and Space Agency," what would your answer be?

Why do we have to have this particular type of agency at this time when we have these other organizations which might, if enlarged somewhat, serve the same purpose?

Why this particular agency? Why space, at the present time, and why should we pass legislation setting up the National Aeronautics and Space Agency, which, as you know, will take over the Advisory Aeronautical Agency?

What would your answer be, Dr. Van Allen?

Dr. VAN ALLEN. Well, sir, I don't think one can name any existing civilian agency of the Government which is constituted to handle a large undertaking of this character. The NACA has a yearly budget of $100 million and it has considered itself as basically a service agency to the aircraft industry and to the Defense Department. I feel that an agency to undertake space research must be a major agency of the Government. It must be a free standing one which has dominant cognizance over certain areas. There is no such agency within the Government establishment at the present time

Mr. NATCHER. Dr Van Allen, this question might be asked. Why not let the NACA proceed? They have $500 million worth of property they are using. They have 7,600 employees, some 4,000 of which are scientists or people qualified along that line.

What would your answer be there? Is this space agency necessary when we have NACA?

Dr. VAN ALLEN. Sir, I have a certain familarity with NACA and I am presently serving on one of their committees. I have served on previous committees of the NACA I think that it is an organization of a high level of competence but its spirit is primarily one of being a service agency to the aeronautical industry and the Defense Department in aeronautics It is conceivable that they could do it, but two things would have to happen. In the first place they would need a greatly expanded charter—one, in fact which is equivalent to the one in the proposed legislation for the NASA.

Next, they need a greatly expanded budget.

The CHAIRMAN. Do they need new minds, too?

Dr. VAN ALLEN. Yes, sir; I think they do in this field. They have relatively little work going on which in my opinion is directly pertinent to the space undertaking.

Mr. NATCHER. Dr. Van Allen, I want to thank you for the fine statement you have made to this committee. I personally believe that now is the time for the establishment of a National Aeronautics and Space Agency, and I think this legislation is imperative. But in order to justify our position and to obtain your reasoning, is why I went into this particular phase of it

Thank you, Mr. Chairman.

The CHAIRMAN. As between the commission form of agency and the director, you would favor one or the other?

Dr. VAN ALLEN. Yes, sir; I favor the commission.

The CHAIRMAN. In any event you favor strongly the creation of a new space agency?

Dr. VAN ALLEN Yes, sir, by all means

The CHAIRMAN Mr. McDonough

Mr. McDONOUGH. Dr. Van Allen, I appreciate your fine statement. It is pertinent and to the point. I appreciate your emphasis upon the civilian development of the use of space with, of course, the attendant results and benefits it will be to the military defense of the Nation

In the title of this Agency, the National Aeronautics and Space Agency, the relationship of aeronautics and astronautics is very close. In your opinion, is this true?

Dr. VAN ALLEN. Well, they have something in common, but I think they are quite different, actually. Aeronautics as, we presently understand it, is quite a long cut below astronautics in technical difficulty.

Mr. McDONOUGH. Would the title of the Agency be more descriptive and better understood if it were a national aero-astronautics agency instead of just space?

Dr. VAN ALLEN. I would personally favor National Commission for Astronautics and Space Research—something of that character. I think it is a little unfortunate to perpetuate the use of the word aeronautics, because that means manned aircraft from Chicago to Washington, and to New York, and so forth.

It should be a cleaner break with the past.

Mr. McDONOUGH. You believe in basic research in astronautics that we will discover new and better means for aeronautical travel?

Dr. VAN ALLEN. Yes, sir, I think that is a long-range possibility—for example, flying 50 people in a rocket from New York to London. I think that it will be a quite long time before we will be doing that reliably. I think, that for at least the next decade, we will not have any appreciable influence on human transportation in this field no matter how vigorously we undertake it.

Mr. McDONOUGH. Do I understand you to say that the title, "National Aero-Astronautics Agency" would be no more descriptive than just the Aeronautics and Space Agency?

Dr. VAN ALLEN. Yes, sir, I think it would.

Mr. McDONOUGH. Space is a vast area and astronautics is the means of communication and travel in space; is it not?

Dr. VAN ALLEN. Yes, sir.

The CHAIRMAN. The new agency will carry on its former work?

Dr. VAN ALLEN. Yes, sir. I know that General Doolittle has stated that they intend to shift the emphasis within the existing NACA establishment rather strongly toward rocket propulsion and guidance and space undertakings.

Mr. McDONOUGH. I think the committee ought to consider the title of the agency as Aero-Astronautics rather than Aeronautics and Space.

I think we have a competent witness here who agrees on the name.

Dr. VAN ALLEN. It is a bit of a mouthful, sir. I prefer a simpler name.

The CHAIRMAN. What counts is the provision of the bill, though?

Dr. VAN ALLEN. Yes, sir.

The CHAIRMAN. We can consider that in executive session.

Mr. McDONOUGH. Do you think that we have in the United States at the present time the potential manpower in scientific minds to carry on from here, or do we have to augment that by a crash program on interesting students in scientific study?

Dr. VAN ALLEN. That is very close to my daily business, teaching science. I think a crash program is very difficult to manage. It takes us 25 years to produce a Ph. D , starting from scratch. It takes us about 8 years, even after a candidate leaves high school.

So I do not think that a crash program can have a very immediate impact on our technological capabilities in the United States. Now,

I am very strongly in favor of stiffening up the educational system all the way down the line, and I think there is quite a significant tendency in that direction now. I include not only science. I think we can well overdo scientific and technical education. I am as interested in having Latin and grammar taught in high school, as I am in having solid geometry and physics. I think we need a stiffening up of the general character of our education.

Technicians can be turned out in a crash program but persons of broad and deep understanding cannot. I feel that it will take a minimum of 10 years to make a substantial change in fundamental education in the United States.

Mr. McDonough. With the scientific manpower we have in the United States at the present time, if it is marshaled, coordinated, and emphasized on space science—do you think we are in pretty good shape right now as compared to Russia?

Dr. Van Allen. Yes, sir, I think we have a vast scientific and technical capability in the United States.

My feeling is that the main element which has been missing is sensible management on a national level for national objectives. I think that one of the most important reasons for the creation of the NASA is to provide effective management and direction of national efforts in the space field.

The Chairman. Dr. Hovde agrees with you on the question of management.

Dr. Van Allen. Yes, sir. We have a great many competent people in the United States devising ways to raise tops of convertible cars when it starts raining on the seats, and so forth. This is all very nice, but I think it is vastly less essential, nationally, than doing some of the things which we have discussed this morning.

I think that the necessary talent exists but that it is not being employed for the national welfare.

Mr. Chairman, may I remark that one special feature of civilian management in the United States is that it provides immediate possibilities for international cooperation. For example, at the present time we have IGY satellite observing stations distributed over the world in at least 20 different countries. Both practically and diplomatically, this is a very fine undertaking, but it is not at all clear how such arrangements can be managed if space is a military undertaking.

I think it is rather difficult to imagine, let us say, the United States Air Force and the Soviet Air Force collaborating on any undertaking, but I can easily imagine our national space establishment collaborating with the corresponding civilian establishment in Russia for mutual benefit, and with the other countries involved in the IGY.

Mr. McDonough. Do you think the IGY effort should be continued instead of terminated this next year?

Dr. Van Allen. Yes, sir, I certainly do.

Mr. McDonough. Are these minitrack stations established for the IGY to be terminated when the year is over?

Dr. Van Allen. That is the specific arrangement. Most of us hope that it will not come to pass, that they will be dismantled at the end of the IGY.

We have stations at the present time in Nigeria, Singapore, British West Indies, Iran, South Africa, Cuba, Hawaii, the Philippines, Ecuador, Peru, Chile, Australia, and so forth.

Mr. McDONOUGH. When the IGY year terminates and we shoot satellites up, we will not have minitrack stations tracking?

Mr. VAN ALLEN. If we do not make arrangements for continuing the operation of observing stations, we will shoot them, and we will not know where they go.

Mr. McDONOUGH. Your plans right now are to continue minitrack stations?

Dr. VAN ALLEN. Yes, sir; also a number of stations called microlock stations, established by the Jet Propulsion Laboratory. There are also a large number of optical observing stations established under the supervision of the Smithsonian Institution. These are all international networks at the present time.

Mr. McDONOUGH. You think this Agency should be authorized to take over the operation of those stations as one of its fundamental purposes?

Dr. VAN ALLEN. Yes, sir, and to make international arrangements for such purposes.

Mr. McDONOUGH. And that this Agency should be the parent body for basic research on astronautics and space exploration?

Dr. VAN ALLEN Yes, sir

Mr. McDONOUGH. Up to what point should it cease to be an operating agency, or should it get into the operating end? Should it build and operate test material? Should it produce in quantity any space ships or satellites?

Dr. VAN ALLEN. My feeling would be, sir, that it should be an operating agency in the sense that it would have proving grounds under its own administration. It should have tracking stations as required—an international network of tracking stations. It should have optical observing stations and should be a self-sufficient agency insofar as conducting the operations are concerned It might well, for example, operate a permanent system of meteorological satellites.

Mr. McDONOUGH. Do you think the Weather Bureau as now constituted should become part of a subsidiary organization to this Agency?

Dr. VAN ALLEN. It should certainly be closely associated with it. I should not like to pass on the matter as to whether it should be absorbed into it or not, but it certainly should be closely associated and I am sure it will be.

Mr. McDONOUGH. That is all, Mr. Chairman.

Mr. NATCHER (presiding). Mr. Fulton.

Mr. FULTON. As the matter now stands, the Vanguard program has been an International Geophysical Year program, so there is no authorization to continue the Vanguard program by law beyond December 31, 1958; is that not right?

Dr VAN ALLEN. That is correct, to the best of my knowledge.

Mr. FULTON. So that in order to continue the Vanguard-Explorer programs, as well as programs of civilian research and exploration into outer space, separate from military weaponry programs, we in the United States need specific statutory authorization; do we not?

Dr. VAN ALLEN. Yes, sir; that is correct.

Mr. FULTON. When you spoke of whistling around the moon in an ion-propelled vehicle, you were not discounting the ion-engine method of propulsion; were you?

Dr. VAN ALLEN. I tend to, as an immediate prospect. But it is a very interesting principle and it will likely have application eventually.

Mr. FULTON. But on the program of research that is now going ahead on ion propulsion you would not, because of that statement, imply that this committee should recommend the cessation of a program of study?

Dr. VAN ALLEN. No; it has prospect of important application in the long run. But it should be recognized that propulsion by means of chemical fuels is enormously more important for the immediate future.

Mr. FULTON. If it will take 10 years to get an ion-propelled vehicle in outer space we should be in the basic study of it now?

Dr. VAN ALLEN. Yes, sir.

Mr. FULTON. Likewise on light propulsion you would recommend continuation of programs of research?

Dr. VAN ALLEN. Yes, sir; on a modest scale

Mr. FULTON. And on sail effect, taking advantage of solar energy you would likewise recommend research?

Dr. VAN ALLEN. Yes, sir; these are sound principles which will have their effects felt in the long run.

Mr. FULTON. Do you recommend the immediate construction of a million-pound thrust engine. Is that the area of magnitude you would emphasize?

Dr. VAN ALLEN. That is an important device and I would say it is a much more immediate need and a much more immediate prospect than a practical engine operating on any other principle you have mentioned.

Mr. FULTON. How long do you think it would take to develop such a vehicle and what would the cost be?

Dr. VAN ALLEN. I understand from people who have been working on this that 3 or 4 years is the general scale likely required for a single unit. Of course one can bundle together four 250,000-pound engines

Mr. FULTON. We are talking of a single unit engine and not 3 ¼-of-a-million engines.

Dr. VAN ALLEN. A single 1-million-pound thrust engine in several years at a minimum. Since no one has done it in this country, the difficulty is not clearly known, of course.

Mr. FULTON. What do you think the magnitude of cost will be?

Dr. VAN ALLEN. I think it runs approximately a billion dollars as the estimate of what is required for full development and prove-in.

Mr. FULTON. At the rate of $500,000 annually, which the Government has started to give for study of the development of the million-pound-thrust engine, it would then require how many years? It would take 2,000 years?

Dr. VAN ALLEN. Yes, sir.

Mr. FULTON. Would you then recommend that the program be stepped up immediately by appropriation of a substantial amount of money for the development of the million-pound-thrust engine for the travel in outer space?

Dr. VAN ALLEN. Well, sir I would think we need a good many things more than we need that. If we really wish to carry a substantial payload into outer space and specifically to the moon, we do need that. I prefer more emphasis on more modest vehicles for

the next 5 years; namely, vertically fired rockets, satellites of the earth and instrumented flights to the moon.

Mr. FULTON. But the President having ordered a lunar shot, then the question comes up, how to do it, and, of course, the million-pound-thrust engine is the vehicle which is best suited.

Would you then not recommend such a program at the present time for the construction of the million-pound-thrust engine rather than put it off?

Dr. VAN ALLEN. I favor getting on with this job; yes, sir. But I do not think such a development should dominate our space effort in the next several years.

Mr. FULTON. You stated in your previous testimony that to project a 1-ton object 5,000 miles through space in your opinion was a military proposal or military jurisdiction.

Why is it not equally a civilian proposal when we might be using that form of transportation for people or for freight or for communication?

Dr. VAN ALLEN. I think the military need is much greater in that particular example. Certainly the Military Establishment must be able to deliver an H-bomb or A-bomb 5,000 miles. Certainly no one disagrees with that as a pressing military requirement.

Mr. FULTON. You said you had experience on obtaining by telemetering or monitoring the results of the signals from the Vanguard and the Explorer programs. Likewise you have stated the amount of information already received from our United States earth satellites has been the equivalent of several hundred years of effort by previously accepted standards?

Dr. VAN ALLEN. That is correct.

Mr. FULTON. Would you kindly tell us in comparison how much information you have received from Sputniks I and II and how many years it would have taken us in the free world to have obtained that knowledge?

First, are you getting the information, and second, how much are you getting?

Dr. VAN ALLEN. We have received the radio signals from both Sputnik I and Sputnik II at numerous stations in the United States. But we have not received from the Soviets the detailed code which is essential to understanding what information is being transmitted.

Mr. FULTON. Under the Geophysical Year arrangements and agreements that code was to be given to you; was it not?

Dr. VAN ALLEN. That is correct, although it was somewhat vague as to how soon they must do that.

I was a member of the United States delegation to Barcelona in 1956 in which this matter was discussed and agreed upon. They are not obligated to provide either the code or the information resulting from interpretation of the measurements until 1 year after the observations have been taken.

That year, of course, has not elapsed. I should say we might well credit them with good faith, in the absence of any evidence to the contrary so far.

Mr. FULTON You do not feel that the Russians have broken any agreements by not giving us the results of their Sputniks I and II firings, nor by giving us a code? That is a very unusual statement.

Dr. VAN ALLEN. I say they have not broken any explicit agreement. I think they have not acted as rapidly as we might expect a friend to

act, but they are within their agreement at the present time. I might say we have not sent, yet, to the Soviets any information of a substantially revealing character of our findings with our Explorers.

Mr. FULTON. Should we?

Dr. VAN ALLEN. We should, and as you perhaps know, on Thursday of this week a number of us are giving public papers on what we have learned so far These papers are being assembled by the National IGY staff and will be transmitted to Russia within the next 2 weeks.

Mr. MCDONOUGH. Are we obligated by treaty?

Dr. VAN ALLEN. It is not a treaty in the strict sense. It is more in the nature of a gentleman's agreement within the IGY structure.

Mr. FULTON. Actually there is no Government agreement at all to give it to them, it is only within the IGY agencies?

Dr. VAN ALLEN. That is right.

Mr. FULTON. It is not a treaty approved by the Senate, nor a binding executive agreement?

Dr. VAN ALLEN. That is correct. It is essentially a matter of informal understanding among scientists working in the two areas and is a matter of record in the IGY proceedings.

Mr. FULTON. In the field of which you have knowledge, are we going to make public a substantial or full amount of the findings we have made of general basic knowledge so that the scientists of the world can have access to them?

Dr. VAN ALLEN. Yes, sir, we are. I will personally present a paper on our results with Explorers I and III. There are three other papers to be given on Thursday at the National Academy. Copies of the papers will be bundled up and sent to all the IGY world data centers within the next week

Mr. FULTON. So our United States scientists have decided on the policy of full disclousre for the gain of scientific knowledge in the whole world?

Dr. VAN ALLEN. Yes, sir. The President has made such a statement of policy and we are complying with it fully.

Mr. FULTON. Let me finish with this. The first is on the commission form as against the director form of organization of the Space Agency.

Personally I prefer the name "Space Agency," United States Space Agency for Research and Exploration, leaving out the word astronautics and aeronautics—one woman has talked to me and suggested that astronautics meant the reading of sailor's pamphlets.

On the setup as it is now we have the 17-man advisory committee, we have the Director, Dr. Dryden, we also have the Executive Secretary, the Associate Director.

In addition to that, we have the Chairman of the Advisory Committee, General Doolittle, who has access to the President when he wants to see the President about the operations of NACA.

Therefore, at the present time we actually have a 4-man operating agency although it is called an advisory committee, with a 7-man executive committee who live in or near Washington and give their full or almost full time to the operations of NACA; do we not?

Dr. VAN ALLEN. Yes, sir.

Mr. FULTON. In effect, then, we have a partial commission setup of the operations at the top level of the National Advisory Committee for Aeronautics right now; do we not?

Dr. VAN ALLEN. It is not clear to me that this is equivalent to a commission.

Mr. FULTON. But partially a commission form, really, at the present time, would you not agree?

Dr VAN ALLEN. Yes, sir, I think it has some resemblance to being a commission but I prefer the AEC pattern wherein the five commissioners are on the job every day as a regular job, and make their full business the determination of policy of the commission.

Mr FULTON As a partial step in that direction I submitted last year a resolution for a joint congressional committee modeled on the Joint Atomic Energy Committee of Congress to start procedures going in that area

May we finish with this

We have the jet air streams above the world that may go 150 to 200 miles per hour, caused by the centrifugal force of the world's turning. They are largely responsible for our tornadoes, cyclones, monsoons and our unusual weather conditions. I saw the atomic shot in Nevada and saw this tremendous cloud of atomic and nuclear material going up into those jet streams. I have been concerned about the changes of weather and the moving of tornado winds that just 10 days ago knocked down some big trees on my farm where we never had such before.

They have moved west from the eastern seaboard, and now are hitting Pittsburgh, Pa

The question is, when you put up these nuclear shots, and this is your field, tremendous clouds go up into those jet streams. First, they physically replace a large area occupied by the jet streams in a straight flow and, second, they do have an effect because they mix in those jet streams a tremendous amount of material that is radioactive and molecularly unstable. We do not know what occurs when the sun hits it—some of those molecules may ionize—because we never have had any experience; is that not correct?

Dr. VAN ALLEN. That is correct.

Mr. FULTON. In your view, is it possible those explosions are having something to do with our change of weather, with Pittsburgh getting big storms where they always went up the east coast?

Dr. VAN ALLEN. No, sir; I would not agree with that.

Mr. FULTON. Why not? I would like to hear that.

Dr. VAN ALLEN. I do not consider myself an expert in this field. But I am familiar with the work of the Weather Bureau and of the President's Commission concerning the possibility of the control of weather.

Mr. FULTON. Why, when we put a tremendous mass up there of radioactive materials that expand tremendously, does it not cause the jet streams of these tremendously potent winds to divert or otherwise mix them up?

Dr VAN ALLEN. It is a quantitative question. The forces of nature are vast. The forces of the atomic bomb are vast. But nature is much more vast than atomic bombs. I think that is the essence of the situation. You ask me do I know. I will say I do not know, but I think the matter is under very competent study, and the burden of conclusion at the present time is that it is not likely that a substantial effect results

Mr. FULTON. At the point of impact of a nuclear explosion, as it extends to these jet streams, is there not a diversion of jet current of winds?

Dr. VAN ALLEN. There must be some local perturbation, but whether that is substantial, I do not know. I think the weight of evidence at the present time is that it is not.

Mr. FULTON. There is a turbulence caused?

Dr. VAN ALLEN. Yes.

Mr. FULTON. Thank you.

That is all, Mr. Chairman.

Mr. NATCHER. Mr. Keating.

Mr. KEATING. Dr. Van Allen, you indicated some of the civilian uses to which outer space might be put, and one was weather.

Dr. VAN ALLEN. Yes.

Mr. KEATING. And the greater facility which we would have in predicting weather. Do you envision the possibilities of controlling the weather, also?

Dr. VAN ALLEN. I would answer about the same way. I certainly do not know. I think it is clear that we must study weather on a much more comprehensive scale in order to approach that possibility. I think it is quite competently agreed now that it will be possible to greatly improve the reliability of weather forecasts by means of satellites. And I think it is agreed that further study of the weather will be the best way, and probably the only way, in which any competent assessment of the possibilities of weather control can be made.

Mr. KEATING. In other words, you will have a much more comprehensive picture of weather, how it is created and changed, from outer space than you do from the atmosphere?

Mr. VAN ALLEN. Yes, sir. With a satellite we can, of course, go around the world every 2 hours, and we can cover the whole surface of the earth in 1 day. We have the prospect for comprehensive and detailed observation to an extent inconceivable by any other means. The spirit of our work at the present time during the IGY is to study the weather and learn more about it, see how it works. I think it is almost certain that we can achieve a great improvement in the reliability of short-term forecasts and, also, long-range forecasts, such as seasonal forecasts. We may be able to reliably predict that this summer will be a dry summer in the Middle West, for example. Whether or not we can exert any control is not at all clear, but I think it is clear that this is the best way to attack that undertaking

Mr. KEATING. It could have far-reaching effects on our relations with other countries where weather is practically their life?

Dr. VAN ALLEN. Yes, and I think we should certainly be aware of the importance of these matters on our agriculture in the United States. It could have a vital influence on agricultural decisions to know in advance what sort of season there is likely to be in an area.

Mr. KEATING. Spoken like a true Iowan.

Dr. VAN ALLEN. I feel very strongly on this.

Mr. FULTON. How do you explain the great increase of tornadoes in the Midwest since the nuclear explosions?

Dr. VAN ALLEN. I do not think that there is any connection between tornadoes and nuclear explosions. Again, I do not consider myself an expert on this matter.

Mr. KEATING. You spoke, also, of a worldwide TV system which could be brought about by further exploration of outer space.

Dr. VAN ALLEN. Yes.

Mr. KEATING. That is as near to a scientific certainty as most anything can be; is it not?

Dr. VAN ALLEN. Yes, sir.

Mr. KEATING. Are there other civilian opportunities which you envision here, other than those two?

Dr. VAN ALLEN. There are others of a more speculative nature. I think those are the two best grounded possibilities, but there are others of a more speculative nature.

For example, we are avidly studying the nature of radio transmission, long-range radio transmission, and there may well be substantial advantages in ordinary radio transmission by virtue of what we learn in the ionic layers of the atmosphere.

Mr. KEATING. Does the solar radiation work you have been doing have possibilities?

Dr. VAN ALLEN. Efforts are being made to find out whether extraordinary outbursts on the sun influence the upper atmosphere and whether, in turn, they have an effect on the communications.

Mr. KEATING. Are you going to bring that radiation down here to heat our homes?

Dr. VAN ALLEN. I do not think we will be able to do that. The anticipated benefits are indirect ones, resulting from a better understanding of the physical phenomena involved. Then, if we have a satellite continuously observing solar radiations, we would know what to expect.

Mr. KEATING. What would the practical effect be on everyday life?

Dr. VAN ALLEN. I think it may well result in better radio communication around the world, for example.

Mr. KEATING. Under the IGY program, is it not a fact that the arrangement was for each country to give its information 8 months after it had started its experiment?

Dr. VAN ALLEN. It was 8 months in the first draft. It was later revised to 1 year.

Mr. KEATING. So the Russians really do not owe us this, nor do we owe the Russians information until 1 year after the experiment; is that correct?

Dr. VAN ALLEN. That is correct

Mr. KEATING. If either country furnished that information within that 1 year they would be complying with the agreement the scientists reached?

Dr. VAN ALLEN. That is correct, sir. I think the spirit of it is that it should be as prompt as possible, but at the outside 1 year. It is evidence of good spirit and good faith to do it promptly, but you are not in violation of the agreement until 1 year has elapsed.

Mr. KEATING. You scientists here plan to do it just as soon as you give your papers?

Dr. VAN ALLEN. Yes, sir.

Mr. KEATING. Will the papers tell the whole story of what we have found out?

Dr. VAN ALLEN. They will contain the whole story up to the time we have prepared them. We have by no means reduced the entire body of data from Explorer III, for example. I have a busy place in Iowa City where we are working day and night doing this. Our paper

which will be given on Thursday of this week contains the results from the first 2 weeks of the flight of Explorer III and for most of the flight of Explorer I. By the end of the summer we will know a good deal more because it is a lot of work just seeing what the results mean.

Mr. KEATING. It is our plan to furnish that information to scientists throughout the world just as soon as we have it available?

Dr. VAN ALLEN. Yes, sir.

Next week a copy of this report will be sent to every national committee participating in the IGY—some 68 countries.

Mr. KEATING. There has been talk here of the $500,000 which is the allotment this year for the study of the million-pound thrust engine. Statements have been made that it would take 200, 300, 1,000, or 2,000 years at that rate to develop it.

Now, I want to bring this out. We have many programs that we have to divide our resources among Is that not right?

Dr. VAN ALLEN. Yes.

Mr. KEATING. You, yourself, do not place first emphasis or first priority on the million-pound thrust engine?

Dr. VAN ALLEN. That is correct; I do not.

Mr. KEATING. It is a highly desirable development and if it is given the priority, if its priority is shoved up, obviously it will take a vastly larger amount of researchers to develop it.

Dr. VAN ALLEN. Yes, sir.

Mr. KEATING. Have you heard anybody seriously contending that this should be a 100- or a 200-year project, or anything of that kind?

Dr. VAN ALLEN. No; I think that is such a long scale we need not bother at all.

Mr. KEATING. In other words, there are many things in the research stage where modest amounts are now being spent. But if they reach a certain point, very much greater sums will have to be spent?

Dr. VAN ALLEN. Yes, sir; I think personally the million-pound engine is a very desirable long-range development is we really wish to send up very large payloads and actually land a party of men, say, on the moon.

Mr. KEATING. But you do not need that million pound thrust engine for what the President has directed, a lunar probe?

Dr. VAN ALLEN. That is correct. We are going to do that within this calendar year with what we have.

I would much rather see heavy emphasis on doing geophysics and astrophysics within the atmosphere of the earth as the primary business in the next several years.

Mr. KEATING. You raised an extraordinary point about our scientists in this country. Nearly everyone who has appeared here has shared your views that we have topnotch scientists in this country. One great problem is to put them to work on the most important projects within and without the Government. It is a good deal like deciding where the most important place to spend money is.

How can we get scientists to shift from working on better ways of putting a convertible top down over to working on a space ship? How can we interest them in that?

Dr. VAN ALLEN. Of course, we cannot in this country just go out and order them to do it. I think we must do it by two means.

Mr. KEATING. You would not be for that?

Dr. VAN ALLEN. No, sir.

Mr. KEATING. You would not be for ordering one to go there and this one here?

Dr. VAN ALLEN. No, sir; I think we ought to make it attractive enough. The attractions are the technical and professional challenges. The financial challenge is present but is, in my opinion, secondary. I think the main challenge is in the spirit and possibilities of the undertaking

I think if we have an NASA in operation we will have no difficulty in getting competent people to do the work.

Mr. KEATING. You feel that the creation of this Agency would be a very important step forward in interesting scientists in this field.

Dr. VAN ALLEN. I think it is a vital step. I think it signifies the national level of interest in this subject, the fact that it is a matter of public policy that we are going to do this vigorously. I think we will have no trouble manning the show with thoroughly competent people.

Mr. KEATING. We not only must man this show, speaking of the NASA or a comparable agency, but we must interest scientists in private enterprises and industrial concerns to take an interest in this field.

Dr. VAN ALLEN. Yes.

Mr. KEATING. You do not have in mind that they will all be concentrated, of course, in the NASA?

Dr. VAN ALLEN. No, sir; I think the NASA should work in large part by contract.

Mr. KEATING. When you said it would take 25 years starting from scratch to develop these Ph. D 's, we do not start from scratch if we are on our toes, do we? You are talking from birth?

Dr. VAN ALLEN. That is correct. We start with entrance in college in my opinion.

Mr. KEATING. In 8 to 10 years, if we are alert, we ought to have the citizenry alerted to the needs of the moment so that we will have a definite improvement in this field?

Dr. VAN ALLEN. I think 8 to 10 years is about right; yes. I don't think that anyone should expect that next year there will be a big change in the output of Ph. D. physicists. That won't be so, no matter what you do.

Mr. NATCHER Mr. Feldman.

Mr. FELDMAN. In response to questions, you stated you served on several NACA boards and also have contact with AEC.

Dr. VAN ALLEN. I did not say close contact, but I have had some contact. I have had a contract with them and I have advised with them some

Mr. FELDMAN. You have had some contact?

Dr. VAN ALLEN. Yes, sir.

Mr. FELDMAN. Has the contact been as close as that you have had with the NACA?

Dr. VAN ALLEN. It is comparable; yes, sir.

Mr. FELDMAN. Is this the basis for your conclusion concerning the commission form versus an individual director?

Dr. VAN ALLEN. You mean the comparison of the way the two agencies work?

Mr. FELDMAN. Yes.

Dr. VAN ALLEN. No; it is not. I think both of them do work out more or less all right. The commission plan appeals to me because

of the diversity of the undertaking we are contemplating I have difficulty visualizing one man with the breadth of competence necessary to direct a national space program in all of its aspects.

Mr. FELDMAN. In your direct testimony you enumerated what those different functions were?

Dr. VAN ALLEN. Yes.

Mr. FELDMAN. I think in answer to a previous question there was talk about the present setup of NACA. The new proposal is section 6 under the functions of the Agency, beginning on page 5, but I am more particularly addressing myself to subsection 3 on page 7 which speaks of additional powers that I do not believe the present NACA has, and that is to:

> Acquire, construct, improve, repair, operate and maintain laboratories, research and testing sites and facilities, manned and unmanned aeronautical and space vehicles, quarters and related accommodations for employees.

and so forth.

It gives the new Agency the right to construct, if I can lift the word out of context, construct manned and unmanned space vehicles.

That seems to be something in addition to what the NACA can do at the moment.

Dr. VAN ALLEN. Well, I do not think so. I do not claim to be an expert on that point, but they are, for example, jointly building the X15 with the Air Force and the Navy. I think they are constructing it, in a loose way of speaking at any rate.

Mr. FELDMAN. If they can perform all these functions, then why do we need a new agency?

Dr. VAN ALLEN. I think we are talking about something of vastly enlarged scope. It is vastly enlarged, vastly larger in expanse, it is vastly larger in breadth. I think it contemplates much wider operation by contract than does NACA. NACA does very little by contract with private institutions.

Mr. FELDMAN. How would you distinguish between atomic energy in outer space and such matters as nuclear power for propulsion, having in mind the difference as between executive agencies and the military liaison of these agencies with atomic energy in outer space and congressional committees?

Dr. VAN ALLEN. You ask what should be the proper governmental agency——

Mr. FELDMAN. Let me see if I can reword the question this way:

NACA is at present engaged in the development of an engine for space propulsion?

Dr. VAN ALLEN. Yes.

Mr. FELDMAN. How would you coordinate that with this new Space Agency?

Dr. VAN ALLEN. I don't have any detailed proposal for that. Coordination is obviously necessary. The AEC is likely the one to continue its development in that area, but it certainly should be fitted to the needs of the Space Agency. I believe that a similar situation exists in the atomic propulsion of submarines, for example.

Mr. FELDMAN. Earlier in your testimony you stated that it was desirable for the new Space Agency to take over all space activities of other agencies in the civilian field. Would you include the Atomic Energy Commission program in this connection?

Dr. VAN ALLEN. I think my statement was that it should have primary cognizance.

It might well be that the Coast and Geodetic Survey would make important contributions in charts and so by primary cognizance I mean dominant control of policy and supervision of activities.

Mr. FELDMAN. That coordination you talked about previously could be done through liaison?

Dr. VAN ALLEN. I think the space Agency must have the necessary power to authoritatively request another Government agency to do work for it in accordance with its needs.

Mr. FELDMAN. And it should have the right to call on these various agencies?

Dr. VAN ALLEN. That is correct. For example, we may need a naval task force such as the Atomic Energy Commission needs for certain purposes. I think it should be clear that, at least through the President, the space Agency can authoritatively request and receive that type of operational support.

Mr. FELDMAN. Should the 1-million-pound thrust engine go to the new NASA or ARPA, or AEC?

Dr. VAN ALLEN. I think that would have to be threshed out. I believe its primary application is to space rather than to military uses and in my own judgment its development should be supervised by the NASA. But I think that sort of decision illustrates the type of decision which must be threshed out between the concerned agencies.

In my prepared statement I urge that in all cases of conflict of interest the decision be favored toward the NASA if it is a space undertaking.

Mr. FELDMAN. If I understand you, then, the new space Agency would be the primary determinant of what should be done. It would then have authority to go to the various agencies to have that function performed or call upon them to do the job; is that right?

Dr. VAN ALLEN. That is what I would urge. I think a major decision such as this one may well need to be decided by the President or by the National Security Council.

Mr. FELDMAN. Would you make the Agency head a member of the National Security Council?

Dr. VAN ALLEN. Yes, sir; I would.

Mr. FELDMAN. No further questions.

Mr. KEATING. That is what I was going to ask.

Do you not think that the importance of this new Agency is such that either the director or the chairman of a commission should have a voice in the formulation of policy at the very highest level?

Dr. VAN ALLEN. Yes, sir; I think he will be a major administrative official of the Federal Government without a doubt.

Mr. KEATING. I am glad to hear you say so in such a forthright manner.

And he should either sit with or be a member of the National Security Council?

Dr. VAN ALLEN. Yes.

Mr. KEATING. Should he not sit in and be present at Cabinet meetings?

Dr. VAN ALLEN. I should think so.

(The prepared statement of Dr. Van Allen follows:)

STATEMENT OF PROF. JAMES A. VAN ALLEN, DEPARTMENT OF PHYSICS, STATE UNIVERSITY OF IOWA, IOWA CITY, IOWA

1. Purposes of a national program of space research

Mr. Chairman and members of the committee, the purposes of a national program of space research are several:

(*a*) Basic investigation of the phenomena of nature on a geophysical and astrophysical scale,

(*b*) Development of civilian and technical applications of the new knowledge and techniques resulting from (*a*),

(*c*) Human adventure,

(*d*) Development of military applications of the new knowledge and techniques resulting from (*a*).

The advancement of the prestige of the United States among nations is often given as a purpose of our space program. Yet I prefer to regard tangible achievements as the purposes with the confidence that such achievements will naturally lead to whatever level of prestige is appropriate.

2. Basic scientific investigation

Basic knowledge must precede the development of means for serving human needs and desires. Outer space is a vast region of human ignorance.

Hence, in my judgment, our national program during the next several years should emphasize the investigation of fundamental geophysical and astrophysical phenomena. During the past 12 years, vertically fired sounding rockets have been quite fruitfully applied to this undertaking; they continue to possess great value in making possible studies within the earth's atmosphere and at such sufficiently high altitudes as may be regarded for certain purposes as above the atmosphere. The firing of sounding rockets should be regarded as an important aspect of a continuing national space program.

But satellites are vastly superior vehicles for investigations which require prolonged observations at high altitudes and for those which require the survey of geophysical phenomena over vast areas of the earth and over great ranges of altitude. In addition, satellites offer certain unique advantages not possessed in any measure by other techniques.

As residents of the earth, our greatest interest doubtless centers upon the physical conditions on the earth and in its astronomical environment.

Our national program in the immediate future should emphasize the thoroughgoing investigation of conditions pertaining to the earth. In due course, corresponding investigations of the moon and of other planets should be undertaken.

3. Development of civilian and technical applications

It is reasonable to expect that applications of new geophysical and astrophysical knowledge will be numerous and important to the welfare of our citizenry. Possibilities for greatly improved weather forecasting and for high-speed communications can already be foreseen with confidence. In addition, there will doubtless be far-reaching advances in the electronic and mechanical arts. And not the least of the benefits of a vigorous space effort will be in providing a great new impetus to education and to cultural and intellectual endeavor in the United States. There is already ample evidence of this tendency.

4. Human adventure

It appears that most scientific observations in space can be most efficiently conducted by automatic equipment in the near future. There will eventually come a stage in the complexity of desirable equipment when the judgment, discretion and intuition of human operators will be mandatory.

For this reason and for the further reason of satisfying the strong urge for human adventure and exploration, systematic preparations should be made for flying men in space vehicles. Such preparations should comprise physiological, psychological, and medical laboratory experiments. The flight of men should be preceded also by a progressive series of flights of biological specimens and living animals with accompanying apparatus for observing and reporting their functions and reactions.

5. Military applications

There will likely be many useful military applications of the results of space research. But, in my judgment, a much broader and more fruitful national program will result if the program objectives are not set by the demonstrated needs of military weapons systems and of other military applications.

6. The proposed National Aeronautics and Space Agency

I heartily endorse the intent of H. R. 11964 in establishing a national space agency, as an operating civilian agency of the Federal Government. In the establishment of such an agency, I feel that it is essential that it be given dominant cognizance, among all Federal agencies, of matters pertaining to space research, developments and operations. Only in this way can a long-range national program be developed for the maximum benefit of our citizenry and for the advancement of our national welfare. The Military Establishment can contribute in many ways to this endeavor and in turn will benefit by it. But as a matter of national policy, I deeply believe that civilian management and primary cognizance will best serve the long-range national interest. In addition, such an arrangement emphasizes, before the world, our primary interest in the peaceful exploitation of space and will greatly facilitate arrangements for international cooperation. Such cooperation is of great practical value (as witness the extensive international network of stations for observing IGY satellites) and is of prime importance in leading to peaceful and mutually helpful international relationships.

7 Funding of civilian space research

The establishment of a National Aeronautics and Space Agency will be a hollow gesture indeed unless it is funded on a scale commensurate with its national role.

The present IGY satellite program in the United States is estimated to have required about $150 million. This effort is evidently only a small beginning in space research. It is therefore apparent that a vigorous NASA which is capable of carrying the dominant Federal role in space research, development, and operations must be funded at a yearly rate of the order of $500 million. Any lesser support will not permit accomplishment of the clear legislative intent of H. R. 11964.

8. Activation of the NASA

In order that the NASA can be placed in full-scale operation as rapidly as possible it appears that the following measures should be taken as soon as enabling legislation and appropriations permit:

(*a*) Transfer to NASA of all facilities, personnel, and activities of the National Advisory Committee for Aeronautics.

(*b*) Transfer to NASA of all such facilities, personnel, and activities of other Federal agencies, including those of the Department of Defense, which are concerned primarily with the exploratory and peaceful aspects of space.

(*c*) Transfer to the administration and supervision of NASA all contractual activities of other Federal agencies which are concerned primarily with the exploratory and peaceful aspects of space.

(*d*) Establish, under NASA administration and supervision, laboratories, proving grounds, firing ranges and international observing networks for the primary purpose of the national civilian space endeavor.

In due course, it may be desirable to consolidate many of the scattered activities which are contemplated in the above But this need not be done in the first instance

9 Relationship of the NASA to the Department of Defense

In the above it has been urged that the NASA be given dominant cognizance, among all Federal agencies, in the exploration and peaceful applications of outer space. The national security requires that the activities of NASA not adversely affect the development of specific weapons systems and the accomplishment of other short-term, specific military objectives Decisions on the proper cognizance of areas in which a conflict of interest with the Department of Defense exists should be made, in general, in favor of the NASA—unless a clear and significant loss of military preparedness can be demonstrated to result thereby.

Mr. NATCHER. The committee will recess now until 2:15 this afternoon.

Thank you very much, Dr Van Allen.

Dr. VAN ALLEN. Thank you, Mr. Chairman.

(Thereupon, at 12 25 p. m., the committee was recessed, to reconvene at 2:15 p. m., same day.)

AFTERNOON SESSION

The committee reconvened at 2:15 p. m., upon the expiration of the recess.

The CHAIRMAN. The committee will be in order.

The next witness is Rear Adm. W. F. Raborn, Director of Special Projects of the United States Navy

We are very happy to have you with us, Admiral. We appreciate the important work that you are doing. You have a very vital assignment in the national interest of our country.

You may proceed, Admiral.

STATEMENT OF REAR ADM. W. F. RABORN,[24] DIRECTOR, SPECIAL PROJECTS, UNITED STATES NAVY

Admiral RABORN Thank you, Mr Chairman. It is an honor and privilege to appear before your committee.

I hope that what I have to say will prove of interest and possibly some help in your very important work in organizing a national space committee for space exploration.

I would like to confine my remarks and remain somewhat in the field in which I am working because I do believe that the type of work which we are doing will have to be done to some degree in any space exploration project that is set up for our country.

I have had the pleasure of briefing Dr. Roy Johnson who is engaged in this type of work for the Secretary of Defense and I am happy to say that he plans to utilize some of our techniques in managing a large complex program in his own shop.

First, I should like to say that it is my personal belief that the NACA provides an excellent foundation on which to expand the responsibilities of that organization for space exploration. I think with participation by all three services that that organization is probably the best on which to build and in which to entrust this most important work.

In the Navy we have a deep and abiding interest in subjects in which any space exploration body would engage, particularly in the lines of navigation, reconnaissance satellites, high-speed aerodynamics, upper-air research, and so on.

There is one thing I should like to point out which I believe may or may not have been given the thought that possibly it should. That is the close environment between the nuclear-powered submarine and a space vehicle.

A nuclear-powered submarine that goes below the surface of the water and remains there for days on end must provide inside of it quite a number of things which must be provided for in a space craft which would be inhabited by humans or living animals.

[24] Raborn, William Francis, Jr., naval officer; b. Decatur, Tex., June 8, 1905; s. William Francis and Cornelia Victoria (Moore) R.; B.S., U S Naval Acad , 1928, student Naval War Coll , 1951-52; m Mildred T Terrell, Apr. 5, 1955, children—Barbara Raborn Richardson, William Francis III Commd. ensign USN, 1928, advanced through grades to rear adm , 1956, designated naval aviator, 1934, assigned battleships, destroyers, aircraft carriers, 1928-40; established Aviation Gunnery Sch , Barbers Point, Pearl Harbor, T.H., 1940-42, exec. officer U S.S. Hancock, Fast Carrier Task Forces Pacific, 1943-45, chief staff Comdr. Task Force 58, Comdr Carrier Div 2, Western Pacific, 1945-47; operations officer Comdr for Air West Coast, 1947-49, research and development guided missiles Bur. Ordnance, 1949-50; dep. dir. guided missile div Office, Chief Naval Operations, 1952-54; comdg. officer U.S.S. Bennington, 1954-55; asst. chief staff Comdr., Atlantic Fleet, 1955; 1st dir. Navy's Fleet Ballistic Missile Program, Baptist, Mason. Home 4121 N. Randolph St., Arlington 7, Va. Office· Bureau of Ordnance, Dept. of Navy, Washington 25.

I should think it would be a source of some comfort to any space organization up for development of these matters to see the work that the Navy is doing and to recognize this as a ready vehicle in which to do some elementary exploratory research.

As you know, our nuclear-powered submarine has to sustain life and sustain life on a high operating level of efficiency. It is necessary that the officers and men aboard these submarines be in topflight physical condition and operating efficiency, both mental and physical, if they are to do their job and do it well.

So the Navy has for many years attempted to improve the environment inside our nuclear-powered submarines, and I am very glad to say that we have made remarkable progress in the last few years.

My own office, concerned as it is with the Polaris submarine, which is a nuclear powered submarine, is quite heavily engaged in technical and scientific pursuits along these lines.

It does not take much imagination or thought to recognize that the physiological and psychological elements which enter into efficient human operations of a nuclear powered submarine are quite real and free.

I have two full-time medical officers, captains in the United States Medical Service, who are engaged in this work in my office full-time, and are heading up a navywide project to better the environment inside the submarine.

I am delighted at the progress which we are making.

I should like to say a few words, if I may, about my organization because I do believe that some of the techniques, managerial techniques, which we have rather successfully employed will be of distinct interest to any other organization which will engage in high-priority work.

As you know, Mr. Chairman, we have had a refreshing new approach to running or managing a top-priority project or work.

The CHAIRMAN. How long ago did that develop?

Admiral RABORN. We started this into effect when I took over this job a little over 2 years ago. I was given the highest priority job within the Navy and told to get it done, that no one is going to tell me how to do it; that I was to be the boss.

Now, this is a rare privilege and also a tremendous responsibility.

I am very happy to say that because we were not inhibited by previous ways of doing things and because we were singularly oriented as to what we were trying to do, we were not hampered by previous organizational concepts or methodology.

So, under the impetus of a truly challenging technical problem, a truly challenging weapon-system concept which offered to the country a distinct addition to their national arsenal, we were able to attract and utilize the services of some of the best technical minds in the uniformed personnel of the Navy, as well as in the Government service civilian organization. They clamored for an opportunity to go to work on this because of these two challenges.

Recognizing that we were trying to do something that has never been done before, and this will be somewhat the position that the head of the new space agency will find himself in, it appeared that we should give our people in the Polaris program maximum responsibility and authority to do their job.

In other words, our secret in being ahead of our program schedules I think can be summed up by saying we got good people, gave them plenty of authority, plenty of guidance, but we did not hamper them.

I was the buffer and I am still the buffer to my people and we try to keep other folks from bothering them.

This is not magic and it is not something new. But one of the things we have evolved which is of interest to any organization trying to get a job done is the type of management technique which we have evolved, as I said before, and which is refreshingly new.

It takes old concepts and puts them together in a distinctly different way.

I am very happy to say that this has attracted attention not only within the three services and has been adopted in whole or in part, but has met searching scrutiny of business firms. There are more than a dozen large firms in the United States and many more smaller ones which have adopted our business management techniques for directing high priority technical work.

Dr. Livingstone, of the Harvard School of Business, spent 2 days in my shop following his appearance before Senator Johnson's committee. He asked our permission to utilize a portion of the techniques in his school. This we were more than happy, of course, to acquiesce in.

If it meets the concurrence of the chairman, I should like to show this on the screen and possibly paint a little better picture than I can do verbally. [Slide.] The purpose of the management team of the special projects office of the Polaris program director. We are to build a Polaris missile; we are to build the nuclear-powered submarine; we are to test the entire system.

The job includes selection and training of the personnel and to provide a completely operational team to the fleet. In other words, for the Polaris submarine missile system.

My office has total responsibility and total authority. We work through existing organizations and this is one of the things I should like to bring to your attention, if I may.

It is quite important, to prevent pyramiding on top of the existing organizations, to utilize those organizations and laboratories which have talent. It has the advantage of going into those organizations and using them only to the extent which your work requires.

As your work needs to expand in the various organizations, laboratories, and so forth, they can accept it if they have the priority.

My office is relatively small.

As you see here, it is divided into three major normal divisions [Slide.] Director of plans and programs, which includes fiscal matters and facilities. It is a resource branch. It provides the plans. It provides the money, the guidance, overall facilities, and so forth.

The Technical Division whose job it is to do the technical research and development necessary to provide the entire weapon system. That includes the missile and submarine and all associated equipment.

And the Director of the Administrative Division.

The CHAIRMAN. To whom do you report?

Admiral RABORN. I report to the Secretary of the Navy, sir.

The CHAIRMAN. Direct line?

Admiral RABORN. Yes, sir; direct line. [Slide.] The special projects management team is a small management team which integrates and

directs the fleet ballistic missiles efforts of over 125 Government agencies and private contractors. These lines leading to this symbol are roughly some of the areas in which we are interested.

It covers the country. It is complex and complicated.

This is where and why really we had to evolve a management system which would be effective and which would allow all parts of the system to be kept in step, if you please.

We went to American Management Association—I did, personally, with some of my people—we spent 3 days there listening to various members of the better-run companies in the United States tell in detail how they gave good management to their companies.

We made tours to some of the better known companies, better recognized from a management standpoint. We went into some detail with their management people and we found no one system which would be applicable to what we were trying to do.

So, necessity being the mother of invention, in this case, we sat down and evolved this sytem which I will try to explain a little bit more fully to you, one which I think will be of help to any space exploration director. [Slide.] Basically when we got the job of doing the full weapons system we sat down with the leading technical people from the many corporations and laboratories that had a major input.

Lockheed missile system division for the missile. The Bureau of Ships, of course, that is going to build the ship for us. The customer, the Chief, Naval Operations, had two representatives. Massachusetts Institute of Technology which was providing, of course, the missile guidance. The Atomic Energy Commission of course, for the warhead. Naval Ordnance Laboratory for fusing, and so forth. The General Electric Co., shipboard fire-control system, and to do the production of the missile guidance. The Aerojet-General Corp. who was to provide the missile motors. The Westinghouse Electric Corp. doing the launching and handling for the submarine. Sperry Gyroscope and North American for shipboard navigation.

We broke down our study groups into these major elements of the part of the missile system and studied our problem for 3 long months.

I am very proud to say this because so many people I am sure are not acquainted with the detailed and painstaking studies which go into a successful project.

Before we started handing money out to our contractors we studied our problem for 3 long months and each in concert with the other, optimizing each of these items by itself and then in relation to the other because what we wanted to do was to have an optimum submarine system.

Polaris missile submarine system: We tried to forecast the technical state of the art some 3 to 5 years in advance and said, because we are sure we can do this 3 to 5 years from now let us strive to set our goals and do these things with these performance characteristics.

This is what is termed in our parlance as the envelope philosophy. We set the physical characteristics that had to be set, the weight, the size, dimensions of the missile, for instance. With that being set we could build the launch and handling gear for the submarine

With the physical characteristics of other elements of the weapons system we could then develop in concert, lock arm in arm and walk forward together in the development of all elements of the weapons system of which the major elements are shown here. [Slide.] To

enable us to do this job this management system, technique of directing this organization, was centered in what we called our management center. That is a room the physical characteristics of which we evolved. These charts are of our own design and which attracted widespread attention.

Basically this is a workshop; this is a tool to help do our job. In this, of course, is centered all the plans, the coordination techniques so necessary in order that decisions made in one area of this weapon system can be made with full knowledge of its effect on other parts of the weapons system.

This is the way you make progress in a hurry and space exploration should, of course, be vigorously pushed. [Slide.] One of the key things which allows a technical group or a director of a project to walk fast, run, if you please, with widespread interest which must be coordinated, is to bring together your top people and as many of them as you can on a regular basis.

I do this every Monday morning. We dedicate every Monday morning to a complete breakdown of the significant events of the past week and its relations with each part of the program.

I get 75 people in here. I have representatives from all my outlying offices, from my major contractors, and any contractor who has a reason to be there, such as the fact he might be a little slow in meeting his schedule.

And the gentlemen in my office responsible for each of their major areas get up and tell their story in front of the entire group. So the level of knowledge and learning of the entire group is brought up to a very high level in the major significant elements of the weapons system, each one of them.

I allow one officer an hour and a half in order that he might take his particular program apart in some detail and spread it out in front of the rest of the group.

Thus we have at a month and a half intervals a complete rundown of everyone else's major interest in some great detail [Slide.] Now, the thing which we have evolved, which has been widely copied, is a charting means. It is new. We attempt to use one chart to show the major elements of any good management system.

If you were the director or the boss of any business, you would like to have some assurance that good planning has been done all the way down the line for the number of years that you are interested in a project. You would like to know that you have a means of trying to feel progress or lack of it.

You would like to have a means of communication of ideas between you and your contractors. All of these are very important elements.

In my visiting of American business firms I found that these major management techniques were utilized in different forms; one man being sick in one organization, no one could even decipher the form, they could not tell me.

This is not a good state of affairs and what we have done is choose a form which would allow us to show evidence of good planning, would provide us a ready means to measure progress, or lack of it, to provide us a ready means of communicating with our contractors.

Briefly in this box we would say the job that has to be done, the investment or cost which would have these components which would be produced in this period of time.

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Responsibilities, direction, supporting, and monitoring of contractor are clearly defined for each item, the actual milestones for doing these things which we have by collective staff action shown up here.

The dates go here, and to serve these purposes. We use this as the four major elements of good management.

[Slide.] This is one filled out, the Polaris missile.

We have broken it down between propulsion, reentry body, flight controls, structure, and auxiliary equipment, missile checkout equipment, system integration, and guidance. [Slide.]

What is 1 line on this chart, the missile, can be broken down in propulsion in 6 more planning charts, 6 more charts to gage your projects, 6 more charts on which you can establish communications with your contractors.

So you break down each of these subareas into smaller subareas. Every week my boys give me a quick snapshot view. We are all busy and at this Monday morning conference the man gets up and says, "My highlights for the week. I am in good shape in all my major work except in one place, in this case a minor weakness which has to do with something or other."

This is a dummy chart so it does not mean much. [Slide.] Shown on this chart then are the four major areas, major chartings which we have provided in some detail.

Now, these are sensitive planning charts. They are milestones of establishing progression, a means of communications, evaluation of progress. [Slide.] Now, we get into the techniques known as the line of balance. Many people do not like to bother with these things because they do not like to work with details.

Yet if you are going to do something in a short period of time, you have to be bothered with a lot of things that you probably would like to ignore. So we have utilized the line of balance technique.

In essence, these are the major elements on these lines of the Polaris missile and the length of time, so many weeks it takes for each of these elements to commence their fabrication, commence their initial design, assembly, and so forth.

And at any one time you can lay your ruler down and you should have accomplished everything underneath it or to the left of it, and the line of balance or these vertical bars for each of these subsurfaces.

If you are up to this line which you have set there for yourself as your goal you are in balance. If you are not, you are out of balance. It is that kind of thing which gives you a detailed feel of the progress of major items of equipment and subitems. [Slide.]

For instance, this is a first state motor which was one line on that other chart. It becomes eight lines here. This is just one stage. [Slide.] These are not very glamorous, but they are distinctly revealing. This is the second stage motor. [Slide.] These are additional charts. I do not expect to try to read them.

This is for a gyro; this is maintained by the Lockheed missile division and he checks on his subcontractors way down the line.

I would like to show you one thing which has created much interest lately [Slide] This is a shot recently off San Clemente about 2 weeks ago in which we for the first time fired a full-scale Polaris missile from underneath the water This gives you one of the many side rings going on in this circus at all times which is the coordination that you

must have right at your fingertips if you are to develop, for instance, in this case, the launcher that goes aboard the submarine.

So we keep track of things of this kind and the progress of it.

This shows the missile having been fired out of the water depths.

The CHAIRMAN. How far does that picture show it is up?

Admiral RABORN. The missile is here and it has been ejected at this point.

Mr. McDONOUGH. What distance does that travel?

Admiral RABORN. I am sorry, sir; that is classified.

Mr. KEATING. Are those boats around that thing?

Admiral RABORN. Yes, sir; but that is some distance away. It is about a mile.

Mr. KEATING. You mean the closest boats are a mile?

Admiral RABORN. Yes, sir; these are buoys, you see.

I will give this as a sample of the kind of operations going on continually in widespread fields, extremely complicated.

That launcher below the water hooked up by coaxial cables underwater to this barge over here is the finest example I have seen of heavy shipyard work and beautiful intricate electronic techniques of instrumentation. It is a rare combination.

It exercised the Navy's talents almost across the board. We had undersea frogmen for instance, that were working below the water at some depths, working on the various gear that goes below; underwater television, underwater cameras, high speed cameras, underwater instrumentation.

It was really a complicated thing. This is just one ring in a multitude ring circus going on at all times which must be dovetailed into the overall program.

This Polaris program, as you know, is considered by most people as the most complicated weapons system we have today.

Mr. KEATING. Is it classified as to how far below the surface of the water the submarine is?

Admiral RABORN. Yes, sir. I shall be glad to tell you separately, sir. I shall be glad to try to answer any questions.

I hope my remarks have been helpful.

The CHAIRMAN. Have you completed your statement?

Admiral RABORN. Yes, sir.

The CHAIRMAN. I have here a news item that appeared in the Boston paper on April 11 on that underwater missile firing. It says:

> The Navy said today it has developed the equipment to fire the Polaris 1,500-mile range ballistic missile from underwater as a solution of the problem of getting into the air where its rocket engine can ignite.

I am reading from the paper now.

Admiral RABORN. Yes, sir.

The CHAIRMAN. That is not classified, is it?

Admiral RABORN. Some very well educated guesses are made from newspaper stories.

The CHAIRMAN. It also quoted you as saying that the launching device and actual hardware is under daily test even before the missile carrying submarines are built; is that right?

Admiral RABORN. That is correct.

The CHAIRMAN. In other words, the Polaris is being tested, but you and your associates are so confident about the success that the

going ahead and building of the submarines is a proper calculated risk to take?

Admiral RABORN. Yes, sir; and this I am glad to say is shared by the Secretary of Defense scientific advisory committee on missiles.

They have put themselves in writing to this effect.

The CHAIRMAN. It says here "1,500-mile range". Can you answer any questions on that?

Admiral RABORN. I will be pleased to within security bounds, sir.

The CHAIRMAN. Is it known that it can go 1,500 miles?

Admiral RABORN. No, sir.

The CHAIRMAN. Is it felt that it can go 1,500 miles?

Admiral RABORN. We are confident that it eventually can; yes, sir. That is no magic range, either. That is no magic limit either.

The CHAIRMAN. Do you view the Polaris weapon system as an alternative to the use of satellites?

Admiral RABORN. If I understand your question correctly, Mr. Chairman, could the Polaris missile be used for satellite work?

The CHAIRMAN. Yes, or as an alternative.

Admiral RABORN. The propulsion system and the Polaris missile is perfectly capable, properly instrumented, I am sure, of placing a useful load in orbit. That is, when it is developed. We do not have it yet.

The CHAIRMAN. Can you give us any information as to the target date?

Admiral RABORN. Mr. McElroy has said he expects to have the missile and the submarine operational in the fall of 1960.

This, of necessity, of course, would mean that we would have the missile sometime before that.

The CHAIRMAN. Coming back to the NACA, you say it is probably the best upon which to build and to entrust this important work. You gave us very powerful evidence, very pointed evidence, as to the importance of management.

Of course, in connection with any new agency that might be established that same question applies.

Admiral RABORN. I would think that to be successful in the development of exploratory work the techniques of good management would be paramount.

The CHAIRMAN. And the primary duty of whoever is in the new agency will be different from that of the past?

Admiral RABORN. If I read the bill correctly, I would think so.

The CHAIRMAN. There would be no reason to establish it unless it were so?

Admiral RABORN. Yes, sir.

The CHAIRMAN. They have been pretty plainly tied up to aeronautics in the past?

Admiral RABORN. Yes, sir.

The CHAIRMAN. Now, they are going into the space field with all its implications, and those who are appointed to administer any agency that is established have to be men of vision and dynamic leadership, men of understanding as well as ability, and not men with a status quo mind?

Admiral RABORN. Those are my beliefs, sir.

The CHAIRMAN. Do you think that men who have been connected with this organization to date, which has been in existence since

around 1915, by reason of their limited, while important, use, while limited in important fields, might tend to have a status quo mind?

Admiral RABORN. I am sure, sir, without attempting to weasel on the answer to that question, that you will find people with status quo minds everywhere. I would think along with new responsibilities in the space age, the NACA could well take in some new blood.

The CHAIRMAN. I am not talking about NACA as an agency to be the foundation. I am talking now about the leadership.

Admiral RABORN. My experience with NACA has made me quite respectful of their capabilities and their leadership.

They are doing some work for us now and we are very happy over the way in which they have responded.

The CHAIRMAN. Have you any views to express as to what form of organizational setup you think would be most effective, a single man at the head—call him a director or administrator—or a commission type?

Admiral RABORN. I believe that a director with considerable authority would be good.

I do believe, though, that he could well have a board of directors, if you please, to assist him in running an organization which would have such widespread technical interest.

The CHAIRMAN. You mean to advise him?

Admiral RABORN. To advise; yes, sir. To have some authority, but subject, of course, to the director.

The CHAIRMAN. If we did not name any board of directors by law you would assume that a wise administrator or director would seek the advice of others through the formulation of necessary committees or groups?

Admiral RABORN. Yes, sir; I would think so.

The CHAIRMAN. There are some who have expressed the opinion that by reason of the diverse activities that constitute outer space exploration a combination, say of five members, with members of the commission well qualified in different fields of activity, might be preferred to a single individual at the head.

What do you think of that?

Admiral RABORN. I would like to see a director put in with considerable authority. Someone who has to make the decisions. If you put the right man in this and give him the right kind of technical assistance in the form of a committee or advisory capacity or collateral authority capacity, but subject to the director, I think that would probably be the best way.

Of course, speaking from the military point of view, we are used to having bosses and yet the bosses that get along are the ones that make full use of their organization and the knowledge that is contained in the organization.

So I think it depends on whom you put in charge of it, really as to how well it works.

The CHAIRMAN. Nobody can ignore the force of that statement.

Whether it is a commission or individual, we could pass the most effective law in the works, if they are incompetent or uncertain or vacillating it would be administered poorly.

And if you have a weak law and good able men they will get the maximum out of it in administering the law. So no one can challenge that statement of yours.

However, I am wondering if the men who have been wedded to the past for many years, to one field like aeronautics, when suddenly shot out into a new and broad field, whether that enables them to have the vision or the outlook to give the required leadership in the new area.

Admiral RABORN. That is a very good question, Mr. Chairman. I can only give my personal views on that matter.

The CHAIRMAN. Will you give your personal views this way? I realize the question is a little embarrassing.

What kind of man do you think the civilian director should be?

Admiral RABORN. This is a tough question to answer from any point of view.

The kind of technical and scientific abilities which will make or break our country's space exploration borders on the true scientist who may or may not be interested in giving forceful direction to the necessary work to carry out the wonderful ideas and theories that he has. So it could well be that we could have an academy or group of distinguished scientists who could be freed to do the things which they are best able to do and that is to come up with scientific theories and scientific approaches which probably, if pursued vigorously, would be most fruitful, and support that man with a good managerial team.

You could take the details of running it off his shoulders.

I have such people in my office. I have true scientists who join men in being quite happy in doing the things which they are far more capable of doing than anyone else, yet they do not run the show.

But the smart director takes the ideas from these wonderful brains and utilizes them.

That, if you could find this combination, in 1 or 2 people, would be quite fortunate.

But you must have forceful direction or implementation, business-like techniques, in organizing and directing the scientific effort or you will fall by the wayside.

So you take the combination, the best business administrator and director in the country; without the wholehearted support of the scientific community you will get nowhere and anyone who is put into that job to assist in such technical direction and management of the project must have a due respect and deference to the scientific contribution of the distinguished men of science.

The CHAIRMAN. Assuming an agency is established, whether it is run by a director or commission, and it becomes law, what sort of civilian type work could this agency do in the immediate future as distinguished from the necessities of the military?

Admiral RABORN. Of necessity, the military thinking has been pointed toward something which they feel will be of distinct assistance to them in carrying out their military applications.

It is true they have a large number of technically and scientifically trained personnel and great talent. They usually have capabilities of giving good direction to technical programs.

By cooperation and for many other reasons they have been able to secure the services of many fine scientists to assist them in their rather narrow objectives.

But as I see space exploration, many, many things fall out which are of distinct value to the military in carrying out their traditional roles.

The CHAIRMAN. We know that everything the military has done has inured to the benefit of mankind. But in the immediate future

with the military necessity which confronts us, what would there be by way of original jurisdiction for a new agency to do?

Admiral RABORN. I think a new agency could best get together and formulate a national program to be parcelled out to existing agencies which would include civilian as well as military scientific agencies and laboratories to assist in the overall progress.

That is the coordination, the national coordination, giving top level direction and not having one or another service going off or concentrating solely on things which they have a normal right to do, of direct benefit to them and their country from their point of view.

I think this is one of the major contributions which a top level group of scientists can do, to formulate a national program.

The CHAIRMAN. Do you strongly support the establishment of an agency of this kind?

Admiral RABORN. Yes, sir; I do, Mr. Chairman.

The CHAIRMAN. I am asking for your own views, now?

Admiral RABORN. These are my own views.

The CHAIRMAN. You think it is in the national interest of our country to do so?

Admiral RABORN. Yes, sir.

The CHAIRMAN. A civilian agency?

Admiral RABORN. Yes, sir.

The CHAIRMAN. Mr. Keating, have you any questions?

Mr. KEATING. No questions, Mr. Chairman.

I have learned a lot from the admiral's presentation. Thank you very much.

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. Admiral, from time to time people point out to us that maybe we are not pooling our scientific knowledge with our allies, as we should. How do you feel about that in your particular assignment at the present time?

Admiral RABORN. I am afraid I am a little at a loss, Mr. Natcher, to answer that question because of these factors:

Our allies have not displayed too great competence—I do not mean this in a derogatory fashion, of course—in solid-propellent motor development, and the details of missile guidance and the details of the atomic warhead are, of course, by law restricted, restricted information. So, to pool our information with them would be a one-way flow to our allies rather than assistance coming this way.

They have displayed much competence in the technical field and I am the first to say that I would welcome, within the freedom given us by law, the exchange of technical information. This largely is being done.

Although I am not directly in this field this is my understanding. I get a continual flow from the other side and representatives from my office have gone on technical missions across the waters.

Mr. NATCHER. Do you believe one of our weak spots has been the result of our failure to put ourselves in a position to hold international scientific meetings? Now, what I have in mind by that, Admiral, is this:

As you and I well know, because of our ban as far as the Communists are concerned, it is impossible to hold meetings in this country since all international scientific organizations are open to all accredited scientific personnel regardless of political affiliation or belief or country and so forth.

On the other hand, according to the information we receive here in this country, Russia each month, maybe daily, is holding meetings in Moscow, and Moscow has thereby established itself probably as one of the scientific centers of the world. They are trying to establish themselves as the scientific capital of the world.

How do you feel, Admiral, from the standpoint of our holding more international scientific meetings in this country, about bringing these minds and these people together? Would it be to our advantage to take steps to correct this matter as far as such meetings are concerned?

How would it affect your particular assignment, or would it?

Admiral RABORN. It would not affect me to any significant degree, Mr. Natcher. I believe that the flow of interchange of technical information is now being carried out to a most acceptable degree between us and other countries. It is being done through many agencies which are classified and I do not care to mention them at this time.

One of the places where maybe we could do better, if such can describe the situation, is to advertise the factor a little bit more.

These large gatherings are primarily window dressing. The true scientist in this country and the true scientist of our allies, are collaborating on a daily basis.

So if you hold conventions, so to speak—I think this is what the Soviets do—it in effect is propaganda.

The true exchanges do not go on in conventions although in some substudy groups you might have a distinct advantage. But I believe there is a certain element of propaganda here.

Mr. NATCHER. The bill we have before us provides for the establishment of a National Aeronautics Space Board. Under this Board, composed of not to exceed 17 members, no more than 8 of the members of the Board shall be designated from appropriate departments or agencies of the Government, with at least 1 to come from the Department of Defense.

How do you feel, Admiral, about the particular Board consisting of 17? Is that too large? That is where you have a Director in charge and as to the divisions there, no more than 8 from the different departments of Government with at least 1 from the Department of Defense. How does that sound to you, Admiral?

Admiral RABORN. It sounds inadequate, Mr. Natcher.

Mr. NATCHER. What part of it sounds inadequate.

Admiral RABORN. The representation from the Department of Defense.

Mr. NATCHER. That is the point I had in mind, Admiral. Do you feel on this particular Board at least one member should come from each military service, or how much should come from the Department of Defense?

Admiral RABORN. I would think that at least one member from each of the military services. Although the Navy has not created too many headlines in space explorations, I did try to point out at the beginning of my remarks that in the true submersible, the nuclear-powered submarine, we are in effect engaged in splendid work today which will be directly applicable to space vehicles which must go outside this earth's atmosphere.

So I think all three services have a distinct contribution to make and have a distinct interest in what goes on in space.

The CHAIRMAN. Do you think they could be specified, or if we put 3 in, let the Secretary of Defense name the 3?

Admiral Raborn. I have confidence that the Secretary of Defense would name the right people. I would think that as long as the law is being drafted and being passed, that it would provide for representation from the three services, equal representation.

Mr. NATCHER. In other words, write it into the law. That would be the best way to handle it now?

Admiral RABORN. Yes.

The CHAIRMAN. One each from the Army, the Navy, and Air Force?

Admiral RABORN. Yes, sir.

The CHAIRMAN. What about the reorganization?

Admiral RABORN. I must plead ignorance about the reorganization.

The CHAIRMAN. This is a little reorganization, itself.

Mr. NATCHER. As I understand it you feel it would be better to make the necessary provision in the law, that is from the standpoint of the future and once and for all.

Admiral, I want to thank you for the fine statement you have made to our committee, and for your appearance.

Admiral RABORN. Thank you, sir.

Mr. NATCHER. I have followed your work somewhat. I want you to know that I think you are doing a fine job.

Admiral RABORN. Thank you.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. I have no questions. I think the Admiral has contributed a great deal in the answers to the questions put to him. I appreciate his appearance.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. How far have you gone on experiments on the reentry of a ballistic missile? Just generally, have you gotten pretty well along?

Admiral RABORN. Yes, sir; we are quite pleased with the status of technical development in those areas. We have them in hand.

Mr. FULTON. And on your guidance system is there a reasonable accuracy at the present time?

Admiral RABORN. We have not fired a missile with a guidance in it. We are in component development in guidance and the state of component development, the knowledge of the requirements of guidance, give us great confidence that it will be good performance.

Mr. FULTON. Actually, the missile could be fired with a directional guidance, either under water, from the surface of the land into the water, or from water to water or from land to land, air to air, as a missile?

Admiral RABORN. Yes, sir.

Mr. FULTON. So there is no real limitation of the Polaris missile similar to submarine type activity or the launching pad?

Admiral RABORN. We know of none.

Mr. FULTON. In general, you are redesigning the submarines so that they will have a different contour to be modern in respect to the Polaris missile, are you not?

Admiral RABORN. Yes, sir, we are; to accept the peculiar requirements of the missile system.

Mr. FULTON. That has been satisfactorily worked out at the present time so that it is practical?

Admiral RABORN. Yes, sir.

Mr. FULTON. The Polaris missile can be fired from under water, but has it yet been tested by firing under ice?

Admiral RABORN. No, sir.

Mr FULTON. As to the three submarines that are going up to the Arctic this summer for their exercises in August, do you intend to have any Polaris testing, or is that classified information?

Admiral RABORN. You are getting into classified waters, sir, if I may suggest.

Mr. FULTON. If the missile can be fired from a submarine, would it not be possible to have the missile's launching pads underwater or underground so that they could not be detected by any radar, sonar, or electronic means, and they could then be aimed at any particular target with ability in guidance, initial guidance. And in the Atlantic you would almost not need any ship, would you?

Admiral RABORN. These are technical possibilities. When you look at the technical desirability you run into a host of problems which would cause you not to do it that way.

Mr FULTON. There have been comments here by a previous naval officer to the effect that he thought there would be a danger in any waters from an unannounced submarine force with unannounced intentions. Is it classified, or could you give us about the area that would be?

Admiral RABORN. I am afraid I missed the point of your question.

Mr. FULTON. Suppose there is an unannounced submarine group coming toward the United States. At what point would it become a danger to us if its potentials were unannounced or we had no knowledge of it?

Admiral RABORN. Of course, it would depend on the capability of the submarine; whether it was purely a submarine equipped to attack surface ships or whether it was a missile-firing submarine or mine-laying submarine. There has been some comment on the 200 miles. I want to identify how and when.

Mr FULTON. But that is not far enough from our shores for the modern missile?

Admiral RABORN. You are speaking of original missile firing from submarines?

Mr. FULTON. We don't know what they are. But if a submarine came within 200 miles they would be too close to us. I think the danger point is further out in the Atlantic.

Admiral RABORN. It depends on the mission of the submarine. If it was a mining mission, naturally, they would come in, possibly, closer to get to our navigable waters on our coast and in the harbors, too. This would be a big threat. One or two mines could block a port.

Mr. FULTON. With the missiles coming into use and now being prepared, does it not move the point of danger to the United States pretty well to the middle of the Atlantic so far as the Navy is concerned?

Admiral RABORN. It does complicate our problem.

Mr. FULTON. We have to move out with additional range, then?

Admiral RABORN. Yes, sir.

Mr. FULTON. I want to compliment you on the development of the Polaris.

The CHAIRMAN. Mr. Ford.

Mr. FORD. I was delighted to see you do a fine sales job on your organization. I think it is an excellent organization. I have been down there, as you know, and have seen it firsthand. I am sure they will continue to do a first-class job.

Visualizing the work that this Agency will have to do, most of it in the initial stages of research and development, do you feel that the organization should have what we call no-year funds for its obligational authority in preference to 1-year authority?

Admiral RABORN. I would highly recommend that, Mr. Ford. The physical problems can well occupy too much attention, too much time of those who are trying to get a job done. No-year funds would certainly be a step in the right direction.

Mr. FORD. If you had to operate on yearly research and development funds, you would have quite a problem?

Admiral RABORN. It would be a highly inefficient operation.

Mr. FORD. Is there too much difference in the research and development program between what you are doing and what this Agency might be doing?

Admiral RABORN. That is correct, sir.

Mr. FORD. The Board is contemplated to have 17 members; 8 from the various Government departments, the remainder from outside. Is a board of that number too great? How do you feel about the number?

Admiral RABORN. I am afraid that I would feel, without too much study of the intent of the bill, it borders on the rather unwieldy, unless you can, maybe, structuralize those numbers into subordinate interests. But it is rather tedious to give everyone an equal vote and then have 17 people get together.

Mr. FORD. Do you have anything comparable to that in your organization?

Admiral RABORN. No, sir.

Mr. FORD. You are the director of the fleet ballistic-missile system, are you not?

Admiral RABORN. Yes, sir.

Mr. FORD. You have these board meetings or these conferences once a week?

Admiral RABORN. Yes, sir.

Mr. FORD. Where you have your various subheads and subcontractors meet with you?

Admiral RABORN. Yes, sir.

Mr. FORD. They are comparable to a board such as the one which you envisage here?

Admiral RABORN. In one sense, yes, sir, but, in another sense, no. I have three people who are my lieutenants, so to speak; the director of planning, who also has the physical facilities and other resources; the technical director; and my director of outlying offices. So, I narrow down to quite a handy and small working group to make decisions.

I never have more than 3 to 5 people on any one of the decisions. Those three people and I are really the corps of executive action.

The CHAIRMAN. So, you sort of create a commission within yourself?

Admiral RABORN. Well, I take my top lieutenants, as any commander does, and arrive at the proper decision, and the ultimate decision, of course, rests in me. I have to accept responsibility for the action, of course.

Mr. FORD. You are the Director, however?

Admiral RABORN. Yes, sir; I am the Director.

Mr. FORD. You have authority to exercise administrative authority and decision making?

Admiral RABORN. Yes, sir.

Mr. FORD. Do you think that is preferable to the commission type of operation on the civilian side?

Admiral RABORN. The scope and mission of this organization about which we are talking is a little different, actually, from what my mission is.

Mr. FORD. You have one thing to do, basically?

Admiral RABORN. It covers the waterfront, so to speak, and literally the United States. It is a wide, complicated thing. I am dedicated to one purpose.

Now, the proposed agency has a little broader field to cover. So I think that this being recognized, you could give considerably more thought to a little different organization from what I have, from an executive direction standpoint.

Mr. FORD. It seems to me it is important to have a director who has responsibility and authority?

Admiral RABORN. I agree with that, sir.

Mr. FORD. However, you set up or organize the board of directors or the adviser or whatever you want to call him?

Admiral RABORN. Yes, sir.

Mr. FORD. How do you feel about a term of office or an indefinite term for the director—the bill provides no set term—appointed at the pleasure of the President for confirmation by the Senate?

Admiral RABORN. I think the language of the bill would be desirable from my personal point of view. I would hate to see this change with administrations. I think they should be placed above such things and if the man has done a good job, he should be allowed to continue.

Mr. FORD. You do feel that at the present state of the art it is desirable to have more than one from the Department of Defense, probably 1 from each of the 3 services?

Admiral RABORN. All three services have a great deal to offer this new Agency and it would be desirable to have a direct representative.

Mr FORD. Is there any question about whether they should be military or civilian from each of the three services?

Admiral RABORN I really have no strong views on that, sir.

Mr. FORD. That is all. Thank you.

Mr. FULTON. Your bringing up the Director raises the question of how he would fit with the Department of Defense. On this point the question comes up that you could not fit your type of organization into the Department of Defense because it has within it the procurement right along with the research and development—and there is no procurement in the Department of Defense, is there?

Admiral RABORN. Not at present; no, sir. I believe Mr. Johnson has recently had that attitude here.

Mr. FORD. Through the ARPA organization?

Admiral RABORN. Yes, sir.

Mr. FULTON. Does it mean we set up a whole new system of procurement? Secretary of Defense Forrestal had recommended that the Department of Defense have a managing group of 100 people and it has ended up at about 5,000.

Should we try to insert in the Department of Defense some sort of relationship which will be a directing, guiding, or organizing group for this director, or should the Department of Defense merely have an overall supervision and then assign down to the forces the various developments?

Where would you put your directional control? Would you move it up into the Department of Defense, or would you leave the military end of it down with the three services?

Admiral RABORN. Stemming from this organization which I envision as purely a civilian organization but outside of the military department, the Department of Defense, I think it would be quite proper that the Department of Defense coordinate the activities of the three services in space exploration matters.

Mr. FULTON. They would simply assign the functions to be performed by the three services?

Admiral RABORN. Yes, sir, very much like they do now in the rest of the work.

Mr. FULTON. So that really on the military side you would set it up in that form rather than set up a whole new procuring agency along your lines in the Department of Defense; would you not?

Admiral RABORN. Yes, sir; that is my personal view.

Mr. FULTON. You would have your research and development function right down in the three services?

Admiral RABORN. Yes, sir.

Mr. FULTON. And be against it in the Department of Defense?

Admiral RABORN. Whatever coordinating capacity you think wise, of course, the Secretary of Defense could well use. But the three services are now set up and have good organization to direct the research and development. So I think in the interest of efficiency they would normally be used.

Mr. FULTON. You would suggest the civilian side not having a complete structure above what the operating mechanisms are—they are a rather simple organization—maybe a commission or a director under the commission or over the commission, a rather simple structure and a very efficient management structure?

Admiral RABORN. That would be very desirable from my point of view.

Mr. FULTON. Thank you very much.

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. Thank you, Mr. Chairman.

I came in late, Admiral, but I would ask you this: Would you adopt generally the idea of this Military Liaison Committee as you have it with the Atomic Energy Commission?

Admiral RABORN. I believe that would be safe. sir.

Mr. BROOKS. Would you do it by Executive order or by legislation?

Admiral RABORN. It does not really matter from my point of view as long as it is effected.

Mr. BROOKS. But you find that works reasonably well, do you?

Admiral RABORN. Yes, sir.

Mr. BROOKS. How do you feel about the Manhattan project that we had in the war?

Admiral RABORN. I am partial to that, sir. That is what I am leading right now, just about.

Mr. BROOKS. That is what I was going to say; you have a little Manhattan project yourself.

Do you think the best results can be attained that way?

Admiral RABORN. If you have a single purpose; yes, sir.

Mr. BROOKS. Single purpose and sufficient power in a single executive, too?

Admiral RABORN. Yes, sir.

Mr. BROOKS. Tell me, how large an organization do you have?

Admiral RABORN. For a year and a half I had 45 officers and 71 civilians in my home office. Now, because I have taken on the responsibility for these additional submarines and the continual growth in the development of machines, which I have responsibility for as well as the personnel, I am up to about 213 or 214 people today.

Mr BROOKS. That is a small organization at that?

Admiral RABORN. Yes, sir.

Mr. BROOKS. You are going to build the new submarine authorized by Congress?

Admiral RABORN. Yes, sir.

Mr. BROOKS. You actually will contract the job out?

Admiral RABORN. The Chief of the Bureau of Ships acts as a contractor for me for this purpose, but I am still responsible to the Secretary of the Navy for the efficient accomplishment of the construction of those submarines to do the Polaris job.

Mr. BROOKS. Does your supervision extend beyond the Polaris job—so far as necessary to accomplish a Polaris installation in a submarine?

Admiral RABORN. If I understand you correctly, sir, let me say that my responsibility encompasses the construction of the submarine and all its appurtenances, particularly those which are specially required for the missile system.

I am responsible for the development of the missile, testing it out and so forth, for the selection and training of the personnel, putting them all together, training them, and delivering them to the fleet.

Mr. BROOKS. You are given responsibility for a finished package?

Admiral RABORN. Yes, sir.

Mr. BROOKS To deliver the submarine staffed and trained and completely built and Polaris installed?

Admiral RABORN. Yes, sir.

Mr. BROOKS. You are responsible for the operation of Polaris, too?

Admiral RABORN. In doing this I would like to hastily add that we utilize existing bureaus and agencies of the Navy which have given fine cooperation.

Mr. BROOKS. Do you have authority to draw on the logistics division of the Navy, too?

Admiral RABORN. Yes, sir.

Mr. BROOKS. Can you draw selected personnel from them?

Admiral RABORN. Yes, sir.

Mr. BROOKS. To whom are you subject in order to meet your requirements?

Admiral RABORN. The Secretary of Navy.

Mr. BROOKS. No one but the Secretary can overrule your order for personnel or materiel?

Admiral RABORN. Yes, sir.

Mr. BROOKS. You really have a Manhattan project within the Navy Department.

Admiral RABORN. That is correct.

Mr. BROOKS. Do you account for the decided progress in the development of the Polaris because you have this type of setup?

Admiral RABORN. I am confident that it has been a major contribution to this, sir, but the key to it has been the full cooperation of the Navy Department and civilian contractors who are part of the team.

Mr. BROOKS. The entire Navy is behind it and wants to see a Navy project come through; is that right?

Admiral RABORN. They all recognize the importance of this in the national-defense scheme.

Mr. BROOKS. You said something I did not quite understand in response to my colleague, Mr. Fulton's, question about eliminating some vessels of the Navy. Did I understand you correctly?

Admiral RABORN. I am afraid I must have been misunderstood.

Mr. BROOKS. He suggested building submarine platforms from which the Polaris might be fired rather than the use of submarines or other vessels.

Admiral RABORN. The gist of that conversation, as I understood it, Mr. Brooks, was the thought advanced by some that possibly you could use submerged launchers located in various places off the coast in lieu of a submarine that can move around.

My answer to him was that while this might be technically feasible it certainly was technically and operationally undesirable.

They could be put out of operation easily by frogmen and so forth.

Mr. BROOKS. They would have the disadvantage of being immobile?

Admiral RABORN. Yes, sir, and roughly unprotected from frogmen.

Mr. BROOKS. The advantage of the Polaris is that it is mobile?

Admiral RABORN. Yes, sir.

Mr. BROOKS. It can be moved from place to place in comparative security?

Admiral RABORN. Yes, sir.

Mr. BROOKS. You have no authority for procurement, you say?

Admiral RABORN. Yes, sir, I have full authority for all procurement.

Mr. BROOKS. The Secretary of Defense under this new organization of advanced research does not overlap you?

Admiral RABORN. Of course we are all subject to the direction from the Secretary of Defense.

Mr. BROOKS. Well, are you?

Admiral RABORN. Yes, sir, I am. And my actions, when approved by the Secretary of the Navy, in turn, my requirements and desired actions are passed on by the Secretary of Defense who reviews them. When I get his approval we have total approval to proceed.

Mr. BROOKS. You really have two bosses, the Secretary of the Navy and Secretary of Defense?

Admiral RABORN. Yes, sir.

Mr. BROOKS. As long as the Secretary of Navy is happy, then, you only have to worry about the Secretary of Defense?

Admiral RABORN. Yes, sir.

Mr. BROOKS. That permits you to go ahead with maximum efficiency and the greatest possible results.

I want to ask you this: There was a speech made in the Southwest over the weekend in which the speaker, an official in the Defense Department, referred to the Russians as having made 17 attempts to reach the moon and failed.

Will you enlighten us upon that?

Admiral RABORN. I must plead ignorance, sir. I wish I knew, but I do not.

Mr. BROOKS. You are in a spot where you should know what is going on with guided missiles.

Admiral RABORN. I do know in my own shop and that is the limit of my responsibility and authority.

Mr. BROOKS. It does not cover everything on the Russians effort to reach the moon?

Admiral RABORN. My job is to beat them.

Mr. BROOKS. Even though they have made 17 attempts and failed, you are ready?

Admiral RABORN. We are going to make a try and make them work.

Mr. Brooks. I commend you for the progress you have made on Polaris. Do the features of the Polaris, which you have developed, make it possible to use that in competition with Jupiter, Jupiter-C, or the missile being used by the Navy, the Vanguard missile?

Admiral RABORN. You mean in space exploration, sir?

Mr. BROOKS. Yes, and missiles, too.

Admiral RABORN. The Polaris missile when developed can be used for land sites.

Mr. BROOKS. The Polaris can. But will it be competitive on land sites with, say, the Jupiter-C or the Vanguard?

Admiral RABORN. No, sir. Well, the Vanguard, of course, is not a missile per se, it is a research vehicle and it has been developed solely for getting things into orbit.

Mr. BROOKS. It may be used for a missile, may it not?

Admiral RABORN. I really don't know. It might, but it distinctly would not be efficient.

Mr. BROOKS. It has a small payload and therefore as a ballistic missile it is limited in possibilities?

Admiral RABORN. Yes, sir.

Mr. BROOKS. What about the Jupiter-C?

Admiral RABORN. This weapon, when it is developed, being a 1,500-mile ballistic missile, carrying a sizable payload, is quite adaptable for use from the land.

Mr. BROOKS. What about the Thor, Admiral?

Admiral RABORN. The same statement goes in connection with the Thor.

Mr. BROOKS. I missed a part of it.

Admiral RABORN. Would you like me to repeat my statement, sir?

Mr. BROOKS. Yes.

Admiral RABORN. When developed, the solid-propellent Polaris will be quite usable from land sites for ranges up to 1,500 miles.

Mr. BROOKS. And it will be competitive with the intermediate range missile up to 1,500 miles, whether it be land based or whether it be submarine based?

Admiral RABORN. If it is submarine based, it gets out of the intermediate-range ballistic missile field because you take it by submarine to distances you can fire the ICBM to and hit the same targets.

With respect to the end objective in hitting the same targets, it is a deterrent.

Mr. BROOKS. You could say the same thing for Thor if it were over in North Africa?

Admiral RABORN. Yes.

Mr. BROOKS. Or if it were somewhere in England or the same thing for the Jupiter-C?

Admiral RABORN. Yes, sir.

Mr. BROOKS. With a 1,500 mile range it would be the equivalent of an intercontinental ballistic missile?

Admiral RABORN. It is just another member of the deterrent family.

Mr. BROOKS. You do not think that other than that it will be competitive with an intercontinental ballistic missile, do you?

Admiral RABORN. That is correct. We are not building it except, as we hope, to be a very welcome addition to the ballistic missile family.

Mr. BROOKS. Placed in a forward area?

Admiral RABORN. Yes, sir.

The CHAIRMAN. And an important addition, too?

Admiral RABORN. Yes, sir.

Mr. FULTON. Could I clear up a misunderstanding?

The CHAIRMAN. Certainly.

Mr. FULTON. The point that you and the gentleman from Louisiana brought out is this, that actually a 1,500 mile missile from either side of a 3,000 mile ocean does not control the ocean. Mr. Brooks adequately pointed out the bases have mobility and I think the inference at the end of our questioning was that the Polaris missile on bases would be confined to places that are restricted waters or waters that have a firm defensive control.

Do you agree with that?

Admiral RABORN. Yes, sir. Fortunately the waters in which the Polaris submarine normally would operate are friendly or neutral waters and would not normally be traversed by sea and air force of any potential enemy.

Mr. FULTON. The strategic importance of the Polaris submarine could be shown by the fact that the 1,500 mile missile could cover practically the entire United States, on either side in range; and with the 1,500 mile missile we could cover 50 percent of the industrial area of Red China and Russia from the sea.

Admiral RABORN. Yes, sir. The sea areas outflank all land areas and with a 1,500 mile missile it is possible to cover practically every significant target in the world.

Mr. FULTON. So it is an outstanding and premium strategic weapon that has been developed by the Navy?

Admiral RABORN. We feel when it comes into being it will be.

Mr. BROOKS. In reference to the strategic value of course no one questions the strategic value of Polaris. It has the facility of moving from place to place.

But, on the other hand, I will say this, that you have to also realize that the Thor or the Jupiter-C have possibilities if placed in forward bases throughout the world, they will have a strategic value. That is true, is it not?

Admiral RABORN. Certainly.

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Mr. BROOKS. It is the old struggle between the land bases and the sea bases and you have that always with you.

Admiral RABORN. We like to think it is not. The submarine-launched Polaris missile, because of its mobility, complements rather than competes with land based missiles. It will be a significant part of our overall deterrent capability.

Mr. BROOKS. I think you are doing a marvelous job. The point I want to ask you though is this. A speaker over the weekend referred to the amazing progress being made in the development of solid propellents.

Can you enlighten us about any recent breakthroughs or progress made in the development of the solid propellents?

Admiral RABORN. There have been no recent breakthroughs in the propellent area. Basically, however, research is going on by all three services in this field and instrumental improvements are coming our way almost on a daily basis. The promise which solid-propellent motors have is largely based on projected ability to reduce the weight of the metal cases surrounding the propellent and which make up the motor in order that the propellent does not have to carry so much dead weight with it when it takes off.

Mr. BROOKS. You mean it does not have possibilities with the first section of the missile, but rather with use in advanced sections of the missile?

Admiral RABORN. It has possibilities in both. You can stage this quite readily. As a matter of fact, it has many advantages, particularly in the later stages. In the first stage, because the solid propellent motor being quite simple, once having been proved out, its ability to get off the ground when you want it to is very comforting.

Mr. BROOKS. It has a smaller possibility of getting out of order than the missile that uses in the first stage liquid propellent; isn't that true?

Admiral RABORN. That is correct.

Mr. BROOKS. Your development of the solid propellent is largely in the hands of private enterprise, is it not?

Admiral RABORN. We like to give full credit to the splendid work which our civilian contractors have done in this area, but I must say that the Army and the Navy together have been largely responsible for the initial research done in this area.

Mr. BROOKS. What about the advanced research that is being done now? Is that with the Army and Navy or private enterprise?

Admiral RABORN. It is being done by all three services now and also by private enterprise, which is quite alert to the attractiveness of getting in this field. I do not mean to depreciate the efforts of private enterprise in the solid-propellent research field, but the vision that put real money into the solid propellent development has lain with the Army and Navy, primarily, of military necessity.

They have put real money in it, and they have stimulated research to a very high degree.

Mr. BROOKS. What is going through my mind is how much can be placed in private enterprise and how much can be carried on by the armed services or the new agency that may be set up.

What would you suggest there?

Admiral RABORN. I think, sir, with the wide and deep reservoir of technical excellence and expertness in the three services, that they should be given really a lead in this.

I have people in uniform now that folks are trying to hire away from me every day. They would not be trying to hire them away if they were less expert than theirs.

Mr. BROOKS. Thank you.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Admiral, I believe you stated that you did not inherit an existing organization and that when you started the Polaris project you started from scratch?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. This project was for the single purpose of developing the Polaris and also putting it on atomic submarines; isn't that so?

Admiral RABORN. Yes; the entire Polaris weapon system, which includes the navigation part of it, the ability to do precise navigation, the development of launching techniques, peculiar needs in the submarine, including the missile.

Mr. FELDMAN. There is a distinction between this kind of project and space exploration projects such as the witness this morning, Dr. Van Allen, told us of. A new agency would have the problem of developing and building vehicles for exploring astronautics and also engaging in space investigation, rocketry, weather, communications, and so on. Each of these separate fields is a distinct part of the science but is a specialized function; is that not so?

Admiral RABORN. I think so.

Mr. FELDMAN. Consequently, a comparison between your type of organization and an organization which would be engaged in these activities might be a little different?

Admiral RABORN. It could be.

Mr. FELDMAN. You would want an expert, for example, on the building of space vehicles, and you would want another who was an expert in the field of astronautics, and one who was an expert in the field of communications as related to space exploration, and one who knew a great deal about rocketry, and another who would be expert in the field of weather?

Admiral RABORN. I think all those are elements of the problem; yes, sir. I also notice that they are common to my concern, too.

Mr. FELDMAN. And you do have experts in these various fields?

Admiral RABORN. I do.

Mr. FELDMAN. Not to the same scientific degree that these other fields would be involved in connection with space? There is a similarity. I recognize that.

Admiral RABORN. I have need for expertness in each of those areas and we are working on them. Let me say to clear this up—I do not want to confuse the picture—the space exploration should, of necessity, be considerably wider and deeper in scope than what the Polaris program encompasses.

Mr. FELDMAN. What I am leading to is this—even though it had a board or commission headed up by a single person, you would still require in that board or on that commission people who are experts in these various fields.

Admiral RABORN. Yes; indeed.

Mr. FELDMAN. It is a question of whether you would want on the Commission itself, or on the Board itself, people with these qualifications.

Admiral RABORN. They have to be connected with the organization and make their voice felt one way or the other.

Mr. FELDMAN. You have had a great deal of experience with the Atomic Energy Commission; is that not so?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. Are you acquainted with the military liaison between the Atomic Energy Commission and the military?

Admiral RABORN. Reasonably so; yes, sir.

Mr. FELDMAN. That liaison in order to be effective has to be on a daily basis; does it not?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. It has to be continuous?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. The purpose of a liaison, of course, is not only to coordinate so that the right hand knows what the left hand is doing constantly, but it avoids duplication and a great many other hardships.

Admiral RABORN. Yes, sir; I think it does.

Mr. FELDMAN. And liaison should not stop with policy at the top; is that not so?

Admiral RABORN. That is correct.

Mr. FELDMAN. You in your organization, for example, see to it that liaison applies right down to the working level?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. If you have a contract with a private company, you see to it that somebody in your organization is at that private company and keeps you informed of developments constantly?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. That is very desirable. That is a type of liaison; is it not?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. So that if such a provision were incorporated into the law, or into a proposal, it certainly would require constant and continuous liaison between the organizations involved?

Admiral RABORN. I think it would be very desirable, sir.

Mr. FELDMAN. Do you feel that a new weapons system like Polaris could have been assigned to NACA?

Admiral RABORN. No, sir.

Mr. FELDMAN. I am not talking about the new NASA; I am talking about the NACA.

Admiral RABORN. No, sir.

I do not think it would be appropriate.

Mr. FELDMAN. In other words, a big assignment requires a new and specially organized agency?

Admiral RABORN. I think every major task has to be objectively viewed to its special requirements and an organization set up to fit the specialized needs.

Mr. FELDMAN. I believe you also said earlier in your testimony that it is possible that NACA, because of its age, would have a certain amount of deadwood; is that not so?

Admiral RABORN. No, sir; I don't believe I made that statement.

Mr. FELDMAN. Well, you didn't use the word "deadwood." But I think you did say there might be people in an organization of that kind who might not be as effective as new people selected when you start on a new program?

Admiral RABORN. I think what I said, sir, was that I agreed that any organization is likely to have deadwood, including my own.

Mr. FELDMAN. Well, it is less likely to be in your own, because it is new; isn't that so?

Admiral RABORN. Yes, sir.

But we will weed them out if they show up.

Mr. FELDMAN. You indicated the NACA in order to do the new job would have to have a lot of new blood infused in it?

Admiral RABORN. Yes, sir. They will need additional talent and help.

Mr. FELDMAN. They would have to have additional talent in this new field?

Admiral RABORN. Yes, sir. They would have to have additional assistance.

Mr. FELDMAN. One last question, sir.

In connection with the development of the nuclear-powered submarine, a lot of new metallurgical problems arose; is that not so?

Admiral RABORN. Yes, sir. There were a fair amount. I am talking about the submarine proper, now.

Mr. FELDMAN. That is right.

Mr. RABORN. Yes, sir.

Mr. FELDMAN. As well as when the nuclear reactor was put in. You had to develop new weapons in order to house that new reactor?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. And those were problems that were met and overcome?

Admiral RABORN. Yes, sir.

Mr. FELDMAN. Corresponding problems, of course, will arise in connection with the development of building of any new space ship that would have nuclear power; that would be nuclear propelled; is that not so?

Admiral RABORN. I think that there would be some problems there, yes.

Mr. FELDMAN. And they are not insurmountable?

Admiral RABORN. We hope not, sir. That is yet to be proven.

Mr. FELDMAN. No further questions.

The CHAIRMAN. Any further questions by any members of the committee?

(No response.)

The CHAIRMAN. Admiral, coming back to the representation on the Advisory Committee, general Advisory Board, it says there shall be at least one from the Defense Department. It does not limit it to one. You understand that, do you not?

Admiral RABORN. Yes, sir.

The CHAIRMAN. And the President could appoint 3 or 4 or 5 if he wanted to.

Instead of prescribing for three members of the Defense Department, don't you think it would be better to have that flexibility where the President could use his judgment?

Admiral RABORN. Well, I am sure whatever judgment the President of the United States would use would be adequate, sir.

The CHAIRMAN. Thank you very much, Admiral.

We appreciate the valuable testimony you have given.

For myself as chairman and all the other members of the committee, I express to you our sincere thanks.

Admiral RABORN. Thank you, sir. It has been a pleasure and an honor to be here.

The CHAIRMAN. The next witness is Dr. Francis W. Reichelderfer, Chief of the Weather Bureau of the Department of Commerce.

Doctor, we are very glad to have you with us today. Have you a prepared statement?

Dr. REICHELDERFER. I have some notes, Mr. Chairman. I understood that the committee was interested primarily in estimates on, and the additional values to, business, industry, and agriculture of perfect weather forecasts.

This is a highly hypothetical question. I can answer questions or make a general statement on it, if you wish.

The CHAIRMAN. Whichever you prefer.

You may make a general statement on the subject, and the members of the committee will probably want to ask you some questions.

Dr. REICHELDERFER. Thank you, sir.

STATEMENT OF DR. FRANCIS W. REICHELDERFER,[25] CHIEF OF THE WEATHER BUREAU, DEPARTMENT OF COMMERCE

Dr. REICHELDERFER. Some 10 or 15 years ago the Weather Bureau undertook to determine the value of weather forecasts and storm warnings to the general public and to the national economy. We took a sampling and hoped we could arrive at a fairly accurate estimate.

However, the figures that were presented to us by business and agricultural interests were so high that we never have been quite willing to come out with the values for fear that someone might think we were exaggerating.

They were well in excess of a billion dollars a year. Now that gives some starting point for determining, for estimating, the value of weather forecasts and storm warnings if one were able to predict definitely and exactly several days ahead.

They would be that much more valuable if one could predict accurately several months ahead. Here are some recent estimates that were produced in certain fields, representative of certain fields, after I found that the committee was interested in figures of this kind.

For example, the university extension service of one of the States estimates that $5 million would be added to farm income in that State alone if forecasts for a period of 5 days or so were 100 percent accurate.

For farming in general, the figure that was given to me is $2½ billion a year.

For the lumber industry, $45 million.

[25] Reichelderfer, Francis Wilton, chief U. S. Weather Bureau, b Harlan, Ind , Aug 6, 1895; s Francis Allen and Mae (Carrington) Lynde, A B., in science, Northwestern U , 1917, hon D Sc , 1939; graduate studies Harvard Univ (meteorol), 1918, Geophysical Inst , Bergen, Norway, 1931; m Beatrice Hoyle June 19, 1920; 1 son, Bruce Allen Appointed naval meteorol. officer, 1918, director of Naval Meteorological Organization, 1922–28, qualified airplane pilot, 1919, airship (lta) pilot, 1931. Meteorol., 1st Transatlantic flight, internat aviation races, spl. assignments and orgn new services U. S. Weather Bur since Dec. 1938 Fellow A. A A S ; hon fellow Inst Aeronaut Sciences (Robert M Losey Award, 1943, pres. Washington sect , 1945–46); mem Wash , Nat Acads. Scis , Am Meterol Soc (councilor 1929–32; 1934–37; 1942–47; since 1948, pres. 1940–41), Internat Meteorol. Orgn 1939–51 (v. p since 1946; mem exec council, since 1939, pres regional commn. IV, 1940–51), World Meteorol. Orgn (pres since 1951), Nat. Adv. Com. for Aeronautics (mem exec. com , since 1939; vice chmn. exec com., since 1945; chmn sub. com. on meteorol. problems since 1938), Am Geophys. Union (pres. meteorol. sect. 1944–47), Philos Soc. of Wash , Wash. Acad. Sciences. Clubs Cosmos, Federal (Washington, D. C.). Author of articles on meteorology. Office: Weather Bureau, Washington

For transportation, exclusive of air transport, $100 million.

In the very important field of water resources, the planning of how to handle water stored for irrigation, in the light of what the weather will be a few days or a few weeks ahead, the estimate is $3 billion a year.

Retail marketing values would be great. Certainly on the order of $50 million or $100 million per year.

Now, these figures are all tentative, Mr. Chairman. No one can tell what could be developed in the application of weather information, weather reports and forecasts, if these reports and forecasts were as definite and specific, for example, as the tables of solar eclipses, lunar eclipses, and so on.

We feel quite sure that the figure would be several billion dollars a year. So much for figures.

As to what this has to do with the subject under discussion: I understand that this estimate was brought into the discussion because of the likelihood that satellites, artificial satellites, would be used to survey the atmosphere, give us hourly or bihourly pictures of cloud systems and storm systems all over the globe, as one means of filling the gaps in our information now.

I should say parenthetically that weather forecasts are not unsatisfactory because the forecaster is indifferent or incompetent but because he has to work with very inadequate data.

We have relatively little information of conditions in the high atmosphere, conditions that undoubtedly have a bearing on the weather. From vast areas in the oceans and in the polar regions we get only very inadequate reports.

So, there are great gaps where severe storms can form and move in toward the land without the meteorologist, without the weather forecaster, knowing much about them in advance. By use of photographs taken from the satellite, it will be possible to get up-to-the-minute reports, or up-to-the-hour reports, of the development of storms at sea, their movement toward the coast, and in this manner give much more definite information as to when they will strike, what their intensity will be, how large they will be, and how long they will last, and other information of that kind that is vital not only for the protection of property and for the protection of life but also to avoid the very great expenses that are connected with preparations in marginal areas where the storm doesn't strike.

Not only will we be able to give weather advice leading to positive protection, but we will enable business and industry to avoid preparations that cost, in many cases, hundreds of thousands of dollars that are unnecessary just because they have to do it to play safe.

Some of the gulf industries have given estimates as to how much it costs them to prepare for a hurricane. And, in many cases, they prepare only as a precautionary measure, not because the hurricane is expected to strike there, but because of some possibility.

The satellite, Mr. Chairman, will be used eventually, I feel quite sure, in a still more fundamental meteorological measurement. That is to determine how much energy the sun pours into the weather machine every day. At the present time, we have no way of knowing how much energy or the fluctuations in energy that reach the atmosphere.

And, as you know, the reason we have weather is that the sun heats the air over the Equator faster than it heats the air over the poles. It sets up an inequality and a circulation that, expressed very simply, gives us, in general, our day-to-day weather changes and the averages that we call climate.

The CHAIRMAN. Does that activity come under this new Agency?

Mr. REICHELDERFER. No, sir. I presume not. I think that I was called here, primarily, to show that the development of the work under this Agency is of primary concern to the Weather Bureau and to the development of meteorology.

The CHAIRMAN. Would sending up satellites and so forth come under this Weather Bureau or this new Agency?

Dr. REICHELDERFER. The Weather Bureau would hope to be able to include in future satellites a meteorological unit compatible in all respects with other elements that are sent up in a satellite.

We have no intention of getting into the business of manufacturing satellite vehicles or rockets. This is not intended. But we do have such a large stake in what can be done with future satellites that the relationship between the Weather Bureau and this new Agency should be clearly understood. Of course, we are one of many. The Coast and Geodetic Survey is another agency that would be very much interested in the mapping that can be carried out from the satellite.

The CHAIRMAN. Is it the intention of the Weather Bureau to project a satellite of its own?

Dr. REICHELDERFER. No; it is not.

The CHAIRMAN. The Weather Bureau would utilize the Space Agency? The Space Agency would carry out this experimental work, and then the Weather Bureau would be given the benefit of it. You would carry on from there?

Dr. REICHELDERFER. That is quite true.

The CHAIRMAN. Just like anything in research that inures to the benefit of the military; then, so far as weapons are concerned, the military will take over.

Dr. REICHELDERFER. Yes.

The CHAIRMAN. I see the distinction.

How long have you been Chief of the Weather Bureau?

Dr. REICHELDERFER. Eighteen years, sir.

The CHAIRMAN. You have been connected with the Weather Bureau prior to that?

Dr. REICHELDERFER. No. I was a naval officer prior to that.

The CHAIRMAN. That is very honorable service, and I am aware of the great service you have rendered. Have you completed your statement?

Dr. REICHELDERFER. Well, one of the interests, also, is in connection with weather control. We do not know a great deal about the possibilities of using the information that would be developed through this new Space Agency in connection with weather control. We do know, however, that the Agency would be expected to produce basic-research data which must be part and parcel of any plans for weather control, whether it is very limited, local weather control, with a modification, or whether it gets into the bolder plans to control the weather on a large scale.

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. Doctor, I want to say, too, that I have observed your work for many years. I recall when we first took up with you the

matter of setting up a program of ferret out, locate, and warn of tornadoes in the Southwest. I think you have done a magnificent job in that respect.

You have testified on the important economic values of knowing something about what is going to happen in the weather. In coming to the program that we have here, Doctor, which is the space vehicle, what sort of instruments would you expect to set up? You would have a photographic arrangement to take pictures. You have said that. What else would you set up in a satellite to give you some assistance in reference to your work?

Dr. REICHELDERFER. There presently is a design—in fact, the instrument is just about completed—to measure the radiation that is received from the sun and the outgoing radiation from the earth.

You see, the sun sends a wide spectrum of energy, which is, some of it, intercepted by the earth. A little of it is absorbed by the air as the rays pass through. More of it is absorbed by water vapor and by cloud particles. Most of the radiation goes on through to the ground. It heats the ground, and some of the radiation, on a much longer wavelength, is radiated back into space.

Now, it is the balance between the incoming and the outgoing that determines how much the atmosphere is heated. This is of basic importance not only in any mathematical approach to the general circulation of the atmosphere which determines our storms, but, also it is important in determining whether the climate is getting warmer as a whole, and why.

This, as you can see, leads directly into questions of preventive measures and possible weather modification. This radiation instrument is the second experiment that would be put on the satellite. It is quite possible, also, that it will be found that some of the phenomena being discovered under the program of the International Geophysical Year will have some bearing on weather. Just within the last few days there was an article about the energy, the radiation, in the night sky aside from the radiation from the stars.

Now, it does not appear that this will have much effect on weather. But we do not know. It is another factor that has just been discovered. And it is conceivable that, in the long run, we will find that this is another element that enters into the surprises that we have in climate and the day-to-day weather changes.

Mr. BROOKS. What do you mean by that particular phenomenon there, the energies in the night sky?

Dr. REICHELDERFER. This press release is just new, and I do not have all of the information, but it is assumed that some of the energy put out by the sun is refracted or reflected around the earth and is present at nighttime when the surface of the earth on the night side is shielded from the sun. And this is something new. This we didn't know of before. It has not been fully explained. It seems to be too small in amount, too slight in intensity, to have any effect. But we cannot say that it has no effect until we know more about it.

Mr. FULTON. That is the Navy research and development finding you are speaking of?

Dr. REICHELDERFER. Yes, sir.

Mr. FULTON. It is a form of light so far that has been invisible?

Dr. REICHELDERFER. That is right.

Mr. BROOKS. The radiation you refer to, is that nuclear radiation that we refer to in atomic power and energy?

Dr. REICHELDERFER. No. I was referring primarily to the radiation from the sun all through the visible spectrum and above and below the infrared and ultraviolet, rather than the type of radiation we have in mind when we speak about radioactive fallout.

Mr. BROOKS. Now, what else do you expect to get from that possibility of utilizing the satellite?

Dr. REICHELDERFER. We do not know what the eventual possibilities will be.

Certainly the most important and the most tangible now are the hourly and bihourly surveys of storm systems completely around the globe, an improvement that might very well bring a new epoch in meteorological understanding. That is the most important. The second is the radiation measurements of energy from the sun and from the earth.

Mr. BROOKS. What about the importance of learning more about the effect of the moon on the weather?

Dr. REICHELDERFER. This, certainly, could be studied. The moon, like the nighttime radiation that I just mentioned, appears to be of relatively little importance in determining weather. I know there are many sages who would dispute that. But we do not find any physical, direct physical, relationship between the moon and the weather.

Mr. BROOKS. Did you find any in reference to the effect of the moon on the tides, especially the high tides?

Dr. REICHELDERFER. Yes; that influence is very direct.

Mr. BROOKS. Would that have any monetary value?

Dr. REICHELDERFER. Well, it certainly could have; yes. There have been various attempts to develop tidal power. I believe the tides are being used for power in some limited localities.

Mr. BROOKS. Now, let me ask you along a different line: You say you can discuss the weather, but cannot do much about the weather. But I have read a lot about weather control

Is there a possibility that you may get into this situation and learn something about the control of the weather?

Dr. REICHELDERFER. There is legislation now pending before Congress to authorize the National Science Foundation to carry on further basic research in weather modification.

The Weather Bureau is directly interested, because some of these experiments will undoubtedly have a bearing on the forecasting of the amounts of rainfall and snowfall—quantitative precipitation forecasts, we call it. This is really very important not only in irrigation projects and flood control, but in warning the public what preparations should be taken in critical situations.

In the floods in Pennsylvania, during the Easter weekend, there was some danger that the waters would exceed the height of the dikes and that there might have to be large-scale evacuation. Now, we were able in this case to predict satisfactorily what would happen so that unnecessary large-scale evacuation was avoided.

But our methods of predicting the amount of rainfall are still far from perfect. We are quite confident that the experimental studies and the research into weather modification will have a direct application in our forecasting of the amount of precipitation.

Mr. BROOKS. Over the weekend, I think night before last, they had 10 inches of rain down in my section of the country.

And they told me up in Texarkana—Texas and Arkansas—the precipitation exceeded 12 inches. The city water supply rose 3½ feet inside of 1 night; so, there is a hazard there.

But do you think there is a possibility of controlling those extreme precipitations in the event you become involved in the space situation?

Dr. REICHELDERFER. We have to look at this whole thing with a very broad view.

Relatively little is known about the general circulation. I hesitate a bit, because we do know many things about the formation of storms, their movements and development. But there is much more to be known.

And until we know all of the factors that enter into the regulation, the determination of how the atmosphere behaves, until we know that, we will not be able to say how far we can go in weather control.

We know that there are many things that can be done. Weather is controlled to a certain extent at the present time in the orchards where the horticulturalists use orchard heaters to prevent frost.

I think we have hardly scratched the surface.

And the knowledge that comes from seeing the atmosphere from above as would be the case with the satellite will certainly give us a scope, a comprehension of what goes on that we have never had before. We are optimistic about the possibilities.

Mr. BROOKS. Would it be fair to say that if this thing will lead to the possibilities of even limited weather control, the financial or monetary benefits are incalculable; is that correct?

Dr. REICHELDERFER. That is correct. I am quite sure that the monetary value would run into several billions of dollars a year.

Mr. BROOKS. If you could relieve us of floods down in the lower Mississippi Valley it would save us a lot of money.

Dr. REICHELDERFER. The National Science Foundation is the general research agency that, it seems to me, should logically carry on the weather modification studies. Now, you have asked specifically about the NASA.

The present National Advisory Committee for Aeronautics has for many years carried on certain special studies in meteorological problems of the NACA. And we have helped carry out these studies—the NACA has carried on studies dealing in particular with gusts, wind gusts, and their effect on aircraft structures.

They have carried on many studies on icing of aircraft and icing in carburetors. So the NACA, I think, should continue to carry on special studies in meteorology that have to do with aircraft and with craft that will travel outer space.

But I do not believe that the NACA or the NASA would be the agency to carry on the general research in weather modification.

I think that is not contemplated. We have unusually good coordination among all of the interested departments in matters of meteorology. The agencies work together fairly closely without duplication and in many respects as one weather agency.

For example, the Weather Bureau uses the weather reports from the Air Force, from the Navy, from the Coast Guard. And they are all put into this general pool of information that is developed for use on the daily weather map which you see posted in one place or another.

Specifically with reference to your question, I don't believe the weather-modification aspects should be in the NASA.

The CHAIRMAN. All your testimony would be more pertinent to the National Science Foundation than to this new agency?

Dr. REICHELDERFER. Except that the new Agency will have, I understand, the responsibility for the satellites where we would get our source information.

The CHAIRMAN. I misunderstood you, Doctor. You wouldn't have the NASA, the new Agency, established with broad jurisdiction, with emphasis on the outer space, and the National Science Foundation competing with reference to satellites or instruments going up into outer space for the purpose of ascertaining the various things you have spoken of.

Dr. REICHELDERFER. No. I see no need for competition. I don't think there would be.

The CHAIRMAN. In other words, the new NASA would have an important function in connection with your testimony with reference to weather control and all of the other aspects you referred to; the NASA would play an important part in ascertaining the information or the discovery.

Dr. REICHELDERFER. It would have an important function in making it possible for us to get the basic data, viewing the atmosphere from outer space.

The CHAIRMAN. In other words you wouldn't have 2 agencies like the 2—I will call them agencies—the National Science Foundation and the NASA—competing with one another in connection with the development of the propulsion to send satellites up into the air.

Dr. REICHELDERFER. Not at all; no, sir. This phase of the weather organization that you have just referred to is a common one. For example, it would be absurd for the Weather Bureau to have ships in the ocean to gather weather reports.

Instead we gather the reports from ships that are there for another purpose.

Now, the satellite will be sent up for general purposes. And what we want again is to get a ride to get the weather reports we need without becoming a space agency ourselves.

The CHAIRMAN. Mr. Metcalf.

Mr. METCALF. No questions.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Doctor, as I understand you, there would be a number of economic benefits to be derived not only by the people but also by the Weather Bureau as a result of the establishment of this new Agency.

Dr. REICHELDERFER. Yes, sir.

Mr. NATCHER. As you probably know, the NACA would go out of existence on the effective date of the NASA. Do you know of any arrangements that the Weather Bureau now has with the NACA that would be affected to the extent that they couldn't be transferred over to the NASA.

Dr. REICHELDERFER. I know of none. I would suppose that the new Agency would find it necessary to have interdepartmental groups of one kind or another, committees, and the work that the Weather Bureau is interested in could continue under that same arrangement.

Mr. NATCHER. Doctor, during the years of 1953 and 1954 we didn't

have much rain down in Kentucky. Since that time we have had a whole lot of rain and the winters are much more severe. Maybe it is because I am a little older, but I feel the cold more.

Do you believe any of this has been brought about as a result of our testing of our atomic weapons and hydrogen weapons and our ballistics missiles—any change in the weather?

Dr. REICHELDERFER. We have a unit working in cooperation with the Atomic Energy Commission that has that question in mind more or less constantly. This unit follows the progress of radio-active clouds and keeps very close track of what happens in the atmosphere as a result of the radio-active fallout.

There is no evidence up to the present time that there has been a change due to the atomic bombs or the hydrogen bombs. The unusual weather, that you just referred to, is the usual thing in weather. You can go back to the records 75 or a hundred years ago, and there will be a series of years very dry and relatively warm, and then a series unusually cold.

And this happens in one place or another all of the time. It is the thing that makes my profession very interesting. There is never a dull moment in trying to keep track of these things.

But I think it is quite sure that up to the present time there have been no large scale, no worldwide, effects from atomic bomb explosions.

We have no doubt that if they were numerous enough there would be an effect. But I think our problems would be other than weather if that were the case.

Mr. NATCHER. Thank you very much.

I also want to thank you for the fine statement you made to our committee.

Mr. FULTON. Doctor, could you put into the record the estimate of the damages you said would be saved on advance warning of hurricanes and tornadoes? Also the estimate on the prevention of flood damage through advance warning.

You commented on those two things.

That is all.

(Material referred to follows.)

1. *Hurricane warning service.*—The present accuracy of hurricane warnings annually saves on the average 900 lives and $100 million in property damage. With completely accurate hurricane warnings issued sufficiently far in advance to permit full-scale precautionary measures, an additional 80 lives and $50 million in property damage could be saved. In addition, completely accurate hurricane warnings would save an estimated $10 million annually in unnecessary preparations for hurricane conditions which are forecast but do not occur.

2. *Tornado warning service.*—The present accuracy of the tornado forecast and warning service annually saves on the average 110 lives and $10 million in property damage. With completely accurate tornado forecasts 3 hours in advance, an additional 170 lives and $5 million in property damage could be saved.

3. *Flood warning service.*—The present accuracy of the flood warnings annually saves on the average 420 lives and $30 million in property damage. With completely accurate flood warnings 36 hours in advance, an additional 70 lives and $30 million in property damage could be saved. In addition, completely accurate flood warnings would save an estimated $5 million annually in unnecessary preparations for floods which are forecast but do not occur.

The CHAIRMAN. Mr. Ford.

Mr. FORD. Doctor, is the Weather Bureau getting any information now from our three satellites which are orbiting; that is, peculiar to the Weather Bureau?

Dr. REICHELDERFER. We are interested, of course, in the temperatures that are sent down, the temperature inside the satellite and the temperature of the skin.

This has no direct bearing so far as we know on our immediate problems of meteorology.

Mr. FORD. Does the Weather Bureau have any part in putting equipment within the satellites?

Dr. REICHELDERFER. Not at the present time. But within the program, within the Vanguard program, it is expected that there will be specific meteorological devices in some of the future launchings. And the Weather Bureau working through the International Geophysical Year does have a device for the radiation measurements that I mentioned.

The cloud-scanning device is being provided by one of the military services—the Signal Corps.

Mr. FORD. Does the Weather Bureau have any connection or has it had any in the past, with NACA.

Dr. REICHELDERFER. Well, we work very closely with NACA. The Chief of the Weather Bureau is ex officio a member of the NACA.

Mr. FORD. Of their Board?

Dr. REICHELDERFER. Of the 17-man Board that is true. I have sat with them for many years.

Mr. FORD. Do you sit with them in their regular meetings which we understand take place 8 to 10 times a year?

Dr. REICHELDERFER. I do, yes.

As you doubtless know the composition of the committee itself changes from time to time, from year to year. And it has at the present time a rather broad representation of different interests. And I would think that the new Agency patterned along that line would include in its membership representatives from some of the fields that will come to the forefront—astrophysicists, and others that will be interested in the outer space aspects of the responsibilities of the new Agency.

Mr. FORD. Do you feel that a board composed of members with a broad view, putting them all together, contributes to the direction and the action of an agency such as NACA?

Dr. REICHELDERFER. I do. Serving as sort of a board of directors, this committee over the years has brought in new blood from time to time, and they have on the whole a very forward look in the development of aeronautics.

I think it has worked out remarkably well.

Mr. FORD. Even an agency such as the Weather Bureau, which superficially you wouldn't think would have much to contribute to the hardware aspects of the NACA, has made a real contribution to the Agency.

Dr. REICHELDERFER. Yes, sir. Of course the NACA's responsibilities include applications of aerodynamics, and this has to deal with the atmosphere.

The NACA deals with the aerodynamics aspects, and we are dealing with the meteorological aspects of the atmosphere.

So there is a closer connection than one might think initially.

Mr. FORD. In your own shop do you have an advisory board of any sort composed of people within and without the Government.

Dr. REICHELDERFER. Not a continuing board. During my tenure

in the office, I have had advisory boards, special advisory boards, from time to time.

At the present time the National Academy of Sciences has a Committee on Meteorology that was organized 2 years ago on my recommendation through the Undersecretary of Commerce for the very purpose of taking a forward look in the possibilities and the future developments of meteorology and advising the Bureau.

This Board is headed by Dr. L. V. Berkner. And the committee has published one interim report.

Mr. FORD. That is advisory rather than supervisory, as far as your office is concerned?

Dr. REICHELDERFER. That is right.

Mr. FORD. That is all.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Just one question, Doctor.

I want the record to be clear on this. I know it is repetitious, but it is repetitious for the sake of emphasis. That is, the savings in dollars and cents will be in excess of several billion dollars per year if we have accurate weather forecasting?

Dr. REICHELDERFER. It certainly would be several billion dollars a year. And when one stops to think that with a gross national product of—what is it—around 400 billions now?—and when you take the whole run of weather—snowstorms, droughts, floods—with weather affecting almost every human endeavor, certainly 1 percent difference in profit or loss for the gross national product as a whole would be very, very conservative.

That is $4 billion. So I would say in excess of several billion dollars.

Mr. FELDMAN. Have you any idea at all of how many lives are lost each year due to failure to have accurate weather forecasting?

Dr. REICHELDERFER. I can give some figures on that. I can give certainly the order of magnitude now and can correct them in the record, if I may.

Years ago before we had the present hurricane warning service, there was an average of 900 to 1,000 lives per year lost. That number was reduced to normally a score, or so.

Now, at the moment the figure is all askew because of the terrible disaster at Cameron, last year.

The forecasts there were quite good. There were other problems on evacuation.

As for tornadoes, the loss of life still runs between 150 and 200 per year. But in the recent tornado at Wichita Falls, Tex., there was one life lost, and local representatives make it quite clear that if it hadn't been for the warnings, that there would have been a loss of many more—perhaps scores.

The same is true of the Fargo tornado last summer. There were good warnings. The people went to their cellars or took shelter otherwise. And undoubtedly scores of lives were saved through those warnings.

Mr. FELDMAN. It is safe to say then, that if we had accurate weather forecasting many lives would be saved which would otherwise be lost.

Dr. REICHELDERFER. There is no doubt about it.

The CHAIRMAN. Any further questions?

(No response.)

The CHAIRMAN. We thank you.

Without objection there will be inserted in the record a memorandum prepared for the members of the select committee by our director and chief counsel, George J. Feldman, and the other members of the staff.

That will be put in the record at this point.

(The memorandum follows:)

SELECT COMMITTEE ON ASTRONAUTICS
AND SPACE EXPLORATION,
HOUSE OF REPRESENTATIVES,
Washington, D. C.

MEMORANDUM

To: Members of the House Committee on Astronautics and Space Exploration.
Subject: National Advisory Committee for Aeronautics.

I am submitting for your perusal a concise description prepared by the staff of the origin, duties, and functions of the NACA.

Much of the material was obtained from the Library of Congress, which has also compiled a summary of significant changes in the practices and relationships of the NACA and the National Aeronautics and Space Agency proposed by the administration. A copy is attached, along with the text of the basic NACA law.

GEORGE J. FELDMAN,
Director and Chief Counsel.

THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

The NACA is a permanent, independent, executive agency, which reports directly to the President. It was established by Congress in 1915. The language authorizing its creation was part of the Naval Appropriations Act. It authorized the expenditure of $5,000 a year "or so much thereof as may be necessary," for 5 years, the money to be spent for experimental work, investigations, clerical expenses, supplies, etc.

Since then, Congress has provided for the NACA the most modern research equipment at a total cost of more than $300 million. Its present operating staff numbers 7,600 scientists, engineers, etc., of whom over 2,000 have professional degrees.

The duty of the NACA, in brief, is "to supervise and direct the scientific study of the problems of flight with a view to their practical solution."

In more detail, its duties and functions, as outlined by law, are as follows:

Duties (50 U. S C. 151b):

"Under such rules and regulations as shall be formulated by the Committee, with the approval of the President, for the conduct of its work, it shall be the duty of the Committee (1) to supervise and direct the scientific study of the problems of flight with a view to their practical solution (2) to determine the problems which should be experimentally attached, and to discuss their solution and their application to practical questions, and (3) to direct and conduct research and experiments in aeronautics in the Langley Aeronautical Laboratory, the Ames Aeronautical Laboratory, the Lewis Flight Propulsion Laboratory and in such other laboratory or laboratories as may, in whole or in part, be placed under the direction of the Committee."

Functions (50 U. S. C. 151b):

"The National Advisory Committee for Aeronautics is authorized—

"(a) to equip, maintain, and operate offices, laboratories, and research stations under its direction,

"(b) to acquire additional land for, undertake additional construction at, and purchase and install additional equipment for, existing laboratories and research stations under its direction; and

"(c) to purchase and maintain cafeteria equipment."

(Aug. 8, 1950, ch. 645, par. 1, 64 Stat. 418)

The NACA operates the following facilities:

Langley Aeronautical Laboratory, near Hampton, Va.; a pilotless aircraft research station, Wallops Island, Va., Ames Aeronautical Laboratory, Moffett Field, near San Francisco, Calif.; the Lewis Flight Propulsion Laboratory, Cleveland, Ohio, and a high-speed flight station, Edwards Air Force Base, Calif. The laboratory at Cleveland has cost up to $110 million to date and employs about 2,800 people

The top governing body of the NACA is a 17-member committee, sometimes referred to in the organization as the "main committee." Its members are appointed by the President and serve without compensation, except for per diem pay and expenses. Ten members represent specified Government agencies, while the remaining members are selected from "persons acquainted with the needs of aeronautical science either civil or military, or skilled in aeronautical engineering or its allied sciences." Nongovernmental members serve 5 years.

Following is the current list of NACA members:

Allen V. Astin, Ph. D., Director, National Bureau of Standards.
Preston R. Bassett, D. Sc.
Detlev W. Bronk, Ph. D., president, Rockefeller Institute for Medical Research.
Leonard Carmichael, Ph. D., Secretary, Smithsonian Institution (Vice Chairman).
Frederick C. Crawford, Sc. D., chairman of the board, Thompson Products, Inc.
William V. Davis, Jr., vice admiral, United States Navy, Deputy Chief of Naval Operations (Air).
James H. Doolittle, Sc. D., vice president, Shell Oil Co. (Chairman).
Paul D. Foote, Ph. D., Assistant Secretary of Defense, Research and Engineering.
Wellington T. Hines, rear admiral, United States Navy, Assistant Chief for Procurement, Bureau of Aeronautics.
Jerome C. Hunsaker, Sc. D, Massachusetts Institute of Technology.
Charles J. McCarthy, S. B., chairman of the board, Chance Vought Aircraft, Inc.
Donald L. Putt, lieutenant general, United States Air Force, Deputy Chief of Staff, Development.
James T. Pyle, A. B., Administrator of Civil Aeronautics.
Francis W. Reichelderfer, Sc. D., Chief, United States Weather Bureau.
Edward V. Rickenbacker, Sc. D., chairman of the board, Eastern Air Lines, Inc.
Louis S. Rothschild, Ph. B., Under Secretary of Commerce for Transportation.
Thomas D. White, general, United States Air Force, Chief of Staff.

The "main committee" meets on an average of once monthly, although the law requires only two meetings a year. During its first 10 years (1915–25) its activities were largely advisory. Since then, however, its chief responsibility has been the conduct of aeronautical research.

The Chairman (and Vice Chairman) of the NACA are elected by the committee. They serve 1-year terms.

Dr. Hugh L. Dryden is the Director. He was selected in 1947. He was then Associate Director of the National Bureau of Standards. His task is to "execute the policies and direct the activities of the Committee." He is "the head of the agency in all matters except those which by law or regulation require action by the Chairman." He receives $20,000 annually.

The Executive Director is John F. Victory, who has been with the NACA since 1915, being its first employee. He is the assistant head of the agency and his task is to "supervise and direct its administrative work."

The Associate Director for Research is John W. Crowley, Jr. His job is to "supervise and direct the scientific and technical activities of the agency."

These are the three officials who perform the actual work. The Committee itself functions as an unpaid board of directors, providing, to quote Crowley, "general direction, policy guidance and inspiration."

The Chairman of the NACA, James H. Doolittle, is apparently the sole officer who has access to the President on matters concerning the operation of the agency.

According to Dr. Dryden, "the Committee meets monthly to discuss research programs and budgets, to survey the present problems and forecast the future problems confronting aircraft designers and operators and the military services, and to initiate the research necessary to meet the needs."

Assisting the Committee in the determination of policy are 5 major and 22 subordinate committees, whose members also serve without compensation, except for per diem pay and expenses. These committees, according to Crowley, "recommend and review the research programs underway and yet to be undertaken" They help maintain effective teamwork among the various governmental and private agencies and the aircraft industry. The total membership of the various committees is more than 400.

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The most important committee in the NACA, other than the "main committee," is the Executive Committee, composed of seven members elected by the Advisory Committee for 1 year. In addition, the Executive Committee includes any member of the Advisory Committee "resident in or near Washington and giving his time wholly or chiefly to the special work of the Committee."

The Executive Committee "shall control the administration of the affairs of the Committee, shall have general supervision of all arrangements for research, and other matters undertaken or promoted by the Advisory Committee * * *. This body is also headed by a Chairman and Vice Chairman, elected by the Executive Committee.

The following committees and subcommittees assist the Advisory Committee in its coordination of aeronautical research and the formulation of its research programs:

Committee on Aerodynamics (including subcommittees on fluid mechanics, high-speed aerodynamics, aerodynamic stability and control, automatic stabilization and control, internal flow, low-speed aerodynamics, seaplanes, and helicopters).

Committee on Power Plants for Aircraft (including subcommittees on aircraft fuels, combustion, lubrication and wear, compressors and turbines, engine performance and operation, powerplant controls, powerplant materials, and rocket engines).

Committee on Aircraft Construction (including subcommittees on aircraft structures, aircraft loads, vibration and flutter, and aircraft structural materials).

Committee on Operating Problems (including subcommittees on meteorological problems, icing problems, flight safety and aircraft noise).

Industry Consulting Committee (which provides advice on policy matters affecting the aircraft industry).

Special Committee on Space Technology (established January 1958). This committee is headed by Dr. H. G. Stever, associate dean of engineering at the Massachusetts Institute of Technology. Other members include:

H. Julian Allen, Ames Aeronautical Laboratory.
Dr. Hendrik W. Bode, director of mathematical research, Bell Telephone Laboratories.
Dr. Milton U. Clauser, director of aeronautical laboratory, the Ramo-Wooldridge Corp.
Prof. Dale R. Corson, Cornell University.
James R. Dempsey, manager, Astronautics Division, Convair.
Robert R. Gilruth, Langley Aeronautical Laboratory.
S. K. Hoffman, general manager, Rocketdyne division, North American Aviation.
Dr. W. Randolph Lovelace, II, Lovelace Clinic.
Dr. William H. Pickering, director, Jet Propulsion Laboratory, California Institute of Technology.
Dr. Louis N. Ridenour, Jr., Missile Systems division, Lockheed Aircraft Corp.
Abe Silverstein, Lewis Flight Propulsion Laboratory.
Dr. James A. Van Allen, department of physics, State University of Iowa.
Dr Wernher von Braun, Director, Development Operations Division, Army Ballistic Missile Agency.

The Space Technology Committee also includes Air Force and Navy representatives.

This Committee, according to Dr. Dryden, will "take a fresh look at the research and development problems of space technology and make recommendations as to the needed programs "

Dr. Dryden added that "the major research fields which must find a place in the overall national program include space mechanics; space environment; energy sources; propulsion systems; vehicle configuration and structure; materials, launch, rendezvous, reentry and recovery; communication, navigation, and guidance; space biology, flight simulation; measurement and observation techniques."

NACA Chairman Doolittle told the Senate Appropriations Committee on February 1958 that the NACA is increasingly devoting more time and effort to the problems of outer space. He said: "* * * 4 years ago, about 10 percent of our activities were associated with space; 2 years about 25 percent; and in 1959 we will be devoting almost half of our time on missiles, antimissiles, and satellites and other space objectives "

But Doolittle added that the NACA still has "an obligation to the airplane, not only because of commercial aviation and the fact that our military offensive posture is largely the result of the airplane, but, because there are extensive

new development programs, the completion of which will run into billions of dollars, still using the airplane—the F-108 fighter long-range interceptor; the 110-A, which is the manned bomber to follow behind the B-52, and the nuclear bomber—all of these projects must be carried on."

The NACA basic law

The NACA was patterned after a similar advisory committee established by the British in 1909. In February 1915, a joint resolution creating an American advisory committee was prepared for submission to Congress with the approval of President Wilson.

The resolution was in danger of being lost, however, in the legislative logjam as the March 4 adjournment date neared. Consequently, it was introduced as a rider to the naval appropriations bill.

Following is the provision in the appropriations act, approved March 3, 1915:

"An Advisory Committee for Aeronautics is hereby established, and the President is authorized to appoint not to exceed twelve members, to consist of two members from the War Department, from the office in charge of military aeronautics; two members from the Navy Department, from the office in charge of naval aeronautics; a representative each of the Smithsonian Institution, of the United States Weather Bureau, and of the United States Bureau of Standards; together with not more than five additional persons who shall be acquainted with the needs of aeronautical science, either civil or military, or skilled in aeronautical engineering or its allied sciences; *Provided*, That the members of the Advisory Committee for Aeronautics, as such shall serve without compensation: *Provided further*, That it shall be the duty of the Advisory Committee for Aeronautics to supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and the application to practical questions. In the event of a laboratory or laboratories, either in whole or in part, being placed under the direction of the committee, the committee may direct and conduct research and experiment in aeronautics in such laboratory or laboratories: And provided further, That rules and regulations for the conduct of the work of the committee shall be formulated by the committee and approved by the President.

"That the sum of $5,000 a year, or so much thereof as may be necessary, for five years is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to be immediately available, for experimental work and investigations undertaken by the committee, clerical expenses and supplies, and necessary expenses of members of the committee in going to, returning from, and while attending meetings of the committee: *Provided*, That an annual report to the Congress shall be submitted through the President, including an itemized statement of expenditures:"

This language establishing the NACA closely followed that used by the British Prime Minister when he announced the formation of a similar committee to the House of Commons on May 5, 1909, in the following words:

"It is no part of the general duty of the Advisory Committee for Aeronautics either to construct or to invent. Its function is not to initiate but to consider what is initiated elsewhere, and is referred to it by the executive offices of the navy and army construction departments. The problems which are likely to arise in this way for solution are numerous, and it will be the work of the committee to advise on these problems and to seek their solution by the application of both theoretical and experimental methods of research.

"The work desired thus falls into three sections: (1) The scientific study of the problems of flight, with a view to their practical solution. (2) Research and experiment into these subjects in a properly equipped laboratory with a trained staff. (3) The construction and use of dirigibles and aeroplanes, having regard mainly to their employment in war.

"The Advisory Committee are to deal with the first section, and also to determine the problems which the experimental branch should attack, and discuss their solutions and their application to practical questions. The second section represents the work referred to the laboratory (the National Physical Laboratory), while the duties concerned with the third section remain with the Admiralty and the War Office."

On April 2, 1915, President Woodrow Wilson appointed the new Committee.

SIGNIFICANT CHANGES IN THE PRACTICES AND RELATIONSHIPS OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS AS PROPOSED FOR THE NATIONAL AERONAUTICS AND SPACE AGENCY BY THE ADMINISTRATION BILL (H. R. 11881, H. R. 11882 AND OTHERS)

A section-by-section examination of the administration bill for a National Aeronautics and Space Agency reveals many points of difference in the operations of the proposed Agency from those of NACA. The principal ones are discussed below.

A. The position of the Director

Section 3 of the administration bill provides that the new Agency shall be headed by a Director who shall be appointed by the President by and with the consent of the Senate. This provision has the effect of elevating the position of the Director from his present status as subordinate to the National Advisory Committee for Aeronautics and its Chairman, to that of actual head of the Agency. At present, the Director is not mentioned in the authorizing legislation for NACA; the top controlling body is the National Advisory Committee which is appointed by the President. The Chairman of the Advisory Committee with the approval of the Executive Committee, in turn, appoints the three principal staff officers of the organization—the Director, an Executive Secretary and the Associate Director for Research. At present, no appointment to NACA is subject to senatorial approval. The Director is the head of the present Agency "in all matters except those which by law or regulation require action by the Chairman"—whatever that means, precisely.

B. The National Aeronautics and Space Board

Section 4 of the administration bill establishes a National Aeronautics and Space Board to supplant the present National Advisory Committee for Aeronautics. The size and manner of appointment to the Board are the same as they now are for the Committee. Whereas no more than 8 members of the Board are to be designated from departments and agencies of the Government, with the remainder to be appointed from nongovernmental sources, present legislation for the Committee provides that 10 of the members shall be appointed from specified Government departments and agencies, with the remainder to be appointed from nongovernmental sources.

The functions of the Board as set forth in section 5 of the administration bill appear to accent an advisory role, in contrast to the policy-formulating role which the Advisory Committee now performs. The Director must consult the Board before taking certain actions as indicated, but as the proposed legislation now stands, he would be under no compulsion to accept its recommendations.

C. The designation of the Chairman of the Board

At present the Chairman of the National Advisory Committee for Aeronautics is elected by the Committee by ballot to serve for 1 year Section 4 (b) of the administration bill proposes that the Chairman "shall be designated from time to time" by the President from among the nongovernmental members of the Board only.

D. Functions of the National Aeronautics and Space Agency

The major change is, or course, the incorporation of responsibility for research, both theoretical and operational, into the problems of outer space, in addition to the continuation of aeronautical research.

E. Broader authority of the National Aeronautics and Space Agency

(1) *Authority to hire employees at salaries comparable with private industry.*—Section 6 (b) (2) authorizes the new Agency to hire employees according to civil-service laws but to pay them salaries comparable to those paid by non-Federal employers for similar work. This constitutes an exception to the Classification Act of 1949 and the Federal Employees Pay Act of 1945.

Present legislation authorizes NACA to hire no more than 30 employees at salaries without reference to the Classification Act, and this action is subject to civil-service approval.

(2) *Authority to acquire or construct additional laboratories at the Agency's discretion.*—Section 6 (b) (3) authorizes the NASA to acquire or construct additional laboratories, as well as to take necessary action concerning existing ones, subject to the appropriation of funds by Congress.

At present, NACA may not build additional facilities without prior congressional authorization and specific appropriations.

(3) *Optional compensation for retired commissioned officers.*—Section 6 (b) (10) authorizes the new Agency to employ and compensate retired commissioned officers of the United States and allows such officers a choice as to whether they are to receive the pay of the Agency position or retirement pay.

Officers so employed by NACA have no such option in compensation.

(4) *Authority to detail Armed Forces personnel for service on the same basis as to the Department of Defense.*—Section 6 (b) (11) gives the Agency authority with Presidential approval to enter into cooperative agreements by which members of the Army, Navy, Air Force, and Marine Corps may be detailed to the Agency for service.

Present legislation for NACA is silent on this matter.

(5) *Authority to pay damages for loss incurred as a result of the conduct of the Agency's functions.*—Section 6 (b) (14) authorizes the Agency certain leeway in adjustment of claims for damages for losses incurred as a result of the conduct of the Agency's functions.

Present legislation for NACA is silent on this matter.

F. Power of NASA to transfer to itself related functions

There is no statutory power given to NACA which is comparable to that in section 8 of the administration bill, wherein the National Aeronautics and Space Agency may within a specified time and with Presidential approval and that of the department or agency concerned, transfer to itself functions of such agency which relate primarily to those of the NASA.

G. Appropriations

Section 9 (a) authorizes funds for the new Agency to be appropriated "without fiscal year limitation."

Funds for NACA are "available until expended when specifically provided in the appropriation act."

THE EXTENT OF CONGRESSIONAL CONTROL OVER THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS AND THAT WHICH IS PROPOSED FOR THE NATIONAL AERONAUTICS AND SPACE AGENCY

A. Congressional control over basic policy of the National Advisory Committee for Aeronautics

Congressional control over NACA is exercised through the appropriations power. Through this power, control over basic policy can be exercised in several ways.

A cut or increase in the total amount of appropriations for NACA from that which the Agency requests can bring about fundamental revisions in the total research program. The agency may be forced to abandon or seriously curtail certain projects in the event of cut in appropriations. Conversely, additional funds will make possible an expansion of research programs.

The present prohibition in the NACA legislation against carrying over funds except when specifically provided may make it impossible to utilize effectively certain funds, with the result that basic policy may be affected. Section 151e of title 50 on availability of appropriations reads:

"Appropriations made to carry out the purposes of sections 151b–151f of this title shall be available for expenses incident to construction, including administrative overhead, planning and surveys, and shall be available until expended when specifically provided in the appropriation act" (Aug. 8, 1950, ch. 645, sec. 6, 64 Stat. 419).

Section 151b of title 50 authorizes NACA to "acquire additional land for, undertake additional construction at, and purchase and install additional equipment for, existing laboratories and research stations under its direction," but congressional approval and a specific appropriation are necessary if it is desired to construct new or additional laboratories and research stations.

B. Congressional control over basic policy of the proposed National Aeronautics and Space Agency

The proposed legislation for NASA appears to differ with respect to congressional control from that presently exercised over NACA in two important respects. In one respect congressional control appears to be lessened, while in the other it is increased.

The proposed NASA appears to have been given more discretionary power in the use of funds appropriated, as well as a release from the restriction against

carryover of funds. This seems to be apparent in section 9 (a) and (b) which state:

"There are hereby authorized to be appropriated without fiscal year limitation such sums as may be necessary and appropriate for the carrying out of the provisions and purposes of this act.

"Any funds appropriated for the construction of facilities may be used for emergency repairs of existing facilities when such existing facilities are made inoperative by major breakdown, accident, or other circumstances and such repairs are deemed by the Director of the Agency to be of greater urgency than the construction of new facilities."

However, top direction and guidance of NASA which in the case of NACA is solely a prerogative of the President, would for the new Agency be a joint Presidential-senatorial decision. Section 3 of the proposed legislation states:

"* * * The Agency shall be headed by a Director who shall be appointed by the President by and with the advice and consent of the Senate * * *."

The CHAIRMAN. The committee stands adjourned until tomorrow at 10 o'clock.

We will meet in the caucus room tomorrow.

(Whereupon, at 4:55 p. m., the committee was adjourned, to reconvene at 10 a. m., Tuesday, April 29, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

TUESDAY, APRIL 29, 1958

House of Representatives,
Select Committee on Astronautics,
and Space Exploration,
Washington, D. C.

The committee met at 10 a. m., pursuant to recess, in the caucus room, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack, Brooks, Hays, Natcher, Sisk, McDonough, Fulton, Keating, and Ford.

Present Also: George J. Feldman, director and chief counsel.

The Chairman. The committee will please be in order.

We are honored in having as the first witness today Dr. James H. Doolittle, Chairman of the National Advisory Committee for Aeronautics, whom everybody knows is a dedicated American.

We are very glad to have you here before us, Doctor, and you are recognized.

STATEMENT OF DR. JAMES H. DOOLITTLE,[26] CHAIRMAN, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, ACCOMPANIED BY HUGH L. DRYDEN, DIRECTOR, AND PAUL G. DEMBLING, LEGAL ADVISER

Dr. Doolittle. Thank you, sir.

I would like, Mr. Chairman, to read a short statement.

The Chairman. You may proceed.

Dr. Doolittle. Mr. Chairman and members of the committee, and counsel:

On April 16 and April 22, Dr. Hugh L. Dryden, Director of the National Advisory Committee for Aeronautics, presented to this

[26] Doolittle, James H(arold), aviator, b. Alameda, Calif, Dec. 14, 1896; s. Frank H. and Rosa C (Shepherd) D.; prep. edn., Nome (Alaska) and Los Angeles (Calif) Junior Coll., 1914-16; A.B., U. of Calif., 1918 (1922); fellow in aeronautical engrng, Mass. Inst. Tech, 1924, M.S., 1924, Sc.D., 1925, m. Josephine E. Daniels, Dec. 24, 1917, children—James H, John P Army aviator, U. S. Army, 1917-30, resigned 1930; maj Reserve Corps. Mgr aviation dept., Shell Petroleum Corp., 1930-40 Apptd. mem. Army Air Corps Investigating Com (Baker Bd.), 1934 Apptd maj U. S Army Air Corps, July 1940, lt colonel to maj. gen., 1942, lt. gen, 1944; commanding Twelfth Air Force in North Africa, Strategic Air Force, 15th and 8th Air Forces, Comdr. 8th Air Force, Okinawa, 1945; on inactive duty since Jan. 5, 1946. Vice pres., dir. Shell Oil Co since 1946, pres Air Force Assn, 1946-47, chairman 1948-49; apptd. chmn of Sec of War's Bd. on Enlisted Men-Officer Relationships; mem. Nat. Adv. Com. for Aeronautics, 1948-50, advisor to Com. on Nat. Security Orgn. and the Joint Congressional Aviation Policy Bd Chairman President's Airport Commission, 1952 Awarded Congressional Medal of Honor, Distinguished Service Medal with one oak leaf cluster. The Silver Star, Distinguished Flying Cross with two oak leaf clusters, Bronze Star, Air Medal with three oak leaf clusters, Bolivian Order of the Condor medal, Yon-Hwei Class III, Grande Officier French Legion d'Honneur, Croix de Guerre with palm, Knight Commander of the Bath, Grand Office of the Order of the Crown with Palm and Croix de Guerre with Palm (both Belgium), 1948, recipient Harmon International Aviation award. Winner Schneider Trophy Race, 1925, awarded Mackay trophy, 1926; Harmon trophy, 1930; winner of Bendix Trophy Race, Burbank, California, to Cleveland, O., 1931 Winner Thompson Trophy Race, 258 68 miles per hr, 1932; also set world's high speed record for landplanes, 1932. Fellow Inst Aeronautical Scis. (pres. 1940), elected hon. fellow, 1950, Royal Aeronautical Soc; mem. Nat. Aeronautical Assn. Contbr. sci. and aeronautical articles Clubs; Army and Navy, Wings. Home 1155 Park Av. Office: Shell Oil Co., 50 W. 50th St., N. Y. City 20.

committee a statement in support of the President's recommendation for establishment of a National Aeronautics and Space Agency. I concur completely with the comments of Dr. Dryden.

Therefore, in the interest of time, I shall limit my prepared remarks to the emphasizing briefly of a number of points, and then attempt to answer such questions as you may wish to ask.

You gentlemen have already spent a tremendous amount of time and energy studying the problems arising from the critical need for our Nation to assert its leadership in the fields of space exploration and space exploitation. You have listened to the testimony of scores of expert witnesses.

One of the most critical of these problems has been whether our national space program should be under military direction or civilian direction or as a joint effort.

My considered answer is that our national space effort must be under civil direction insofar as the very important, nonmilitary aspects of the program are concerned, with the necessary proviso that there must be effective cooperation and coordination between the civil space work and the military space work.

From my years in uniform, I know that the military space projects will benefit greatly from the work of the NASA. It would be difficult, or impossible, for the Nation to fully accomplish its major space objectives if the program were under strictly military control. Direction and leadership of the program must be the responsibility of a civilian agency as provided in the bill.

The President and several Members of Congress have, I believe, clearly reflected the sentiment of our Nation by their proposals that weapons be barred from space by international agreement.

We must, however, have whatever space capability may be required to protect our national welfare.

We must also lead in the peaceful exploration of space, gathering there the vast amounts of new scientific knowledge that may well have the most profound effects upon the future of life on our earth.

I spoke of the essentiality of cooperation and coordination between our military and civilian space workers. Here is where the President's recommendation that the NACA be the nucleus of the NASA is especially important.

For more than 40 years the NACA, while maintaining its independent status and freedom to formulate its own programs, has proved its ability to work most effectively with the military services in pioneering the advances that have made it possible for the United States to maintain leadership in aviation.

A second point I should like to emphasize is the importance of the NASA being organized so that there will be adequate representation of the points of view of all the facets of both government and civil life that are concerned with the national space program. This will be accomplished through the National Aeronautics and Space Board of 17 members.

This committee is not a device that gets involved in the detailed administration of the Agency with consequent delay in time. The NASB, the Board, will serve the Director of the NASA in an advisory capacity.

The Board, as outlined in the bill, would be composed of not more than eight men from the Government with the rest from private life.

Only one Government agency is specifically named, the Department of Defense.

I would expect representation on the Board from the Atomic Energy Commission and the military services, the Army, Navy, and Air Force, to be so obviously desirable as to make unnecessary spelling out this requirement in the legislation.

This would be true also for the National Science Foundation.

Equally sure in my mind, even without legislative stipulation, would be adequate representation on the Board of the National Academy of Sciences through the civilian membership.

The language of the bill is broad. The authorities it contains are necessary to enable the NASA to marshal America's resources as may be needed to carry forward our national space program.

Finally, I should like to stress the importance of planning our national space program to insure that it best satisfies the needs of the United States. As I see it, our projects should be designed to further two goals:

1. The sending into space of highly instrumented vehicles that will send back, or bring back, the new knowledge that our scientists need; and

2. The sending into space of craft that will carry men on their voyages of exploration.

We must learn how to being them back, alive.

In our programing, and in our accomplishments of those programs, we should keep our eyes focused on these objectives. The fact that the Russians may accomplish some specific objectives in their space programs first should not in itself be permitted to divert us from our own designated objectives.

To do what we need to do most certainly will require that we spend substantial amounts of money. It will require that we reach and maintain a high level of effort over a period of many years.

As a nation, we have the scientific competence and the material resources to win our rightful destiny in space. This we must do.

I thank you, Mr. Chairman.

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. Thank you, Mr. Chairman.

General, I might say parenthetically that I recently had the privilege of seeing some of the original pictures taken on the famous Doolittle raid on Japan—Tokyo. I am impressed by amazing progress which has been made in conquering the air in the few short years that have passed since that raid which you made on Tokyo.

I have been impressed by the stage of the development which indicated such hazards undertaken by our men who made that raid along with you.

Jack Simms has been very instrumental in bringing me up to date on that. I appreciate it.

I want to ask you about the suggestion presented here regarding the new committee, NASA, which would embody the principles and the organization of the NACA.

Of course, I think the organization that you have headed, the National Advisory Committee for Aeronautics, has had a long and distinguished career, too; it has rendered outstanding service.

It is with reluctance that I see it incorporated in another organization.

Will we lose any of the advantages we have gained by doing that?

Dr. DOOLITTLE. No, sir. The new organization, the NASA, not only absorbs the NACA, but it also takes on all of its duties, all of its people, and all of its facilities. So the excellent work that the NACA has been doing in the past will continue to be done under the new organization.

Mr. BROOKS. The merging of one into the other will eliminate, to some extent, the connection which the military has with the NACA.

I notice the reference in your statement, but do you think that is adequate protection for a continuation of the military programs?

Dr. DOOLITTLE. I see no change in relationship between the military services and the NACA as a result of the establishment of the NASA. This relationship has been excellent through the years. I am satisfied it will continue.

Mr. BROOKS. I think it has been excellent, but this new suggestion provides for only one mandatory representative from the military in the new organization.

I notice how you pass by it, that the apparent need would be sufficient to make it mandatory, without writing into the law, that all the services be represented.

Dr. DOOLITTLE. My own feeling is that the Army, Navy, and Air Force should be represented. I am satisfied they will be whether it is written into the law, or not.

Mr. BROOKS. If it is written into the law, then there should be three spaces for the military?

Dr. DOOLITTLE. Four spaces, sir.

Mr. BROOKS. Defense, Army, Navy, and Air Force; is that it?

Dr. DOOLITTLE. That would be my recommendation. If my opinion were asked who to have on as the 8 members from the Government, I would say that 4 of those spaces should be for the Department of Defense; that would be a Department of Defense representative and a uniformed representative from the Army, Navy, and Air Force.

The CHAIRMAN. Are they on there now?

Dr. DOOLITTLE. At the present time, sir, there are 2 representatives in uniform from the Navy; 2 from the Air Force, and there is legislation pending to put 2 on from the Army. That legislation would increase the number of members of the board from 17 to 19.

The CHAIRMAN. That is not the Advisory Board, now?

Dr. DOOLITTLE. The Army representatives are on the subcommittees, but not on the main board.

There are 2 military members from the Air Force, and 2 from the Navy, plus 1 from the Department of Defense. So we presently have five members from the Military Establishment.

Eventually we would have 7, increasing the total number of board members to 19 had that legislation passed.

However, this proposal is holding up the legislation.

Mr. BROOKS. Then you would have the same relative situation if you allowed one representative from each one?

Dr. DOOLITTLE. I think one is adequate.

Mr. BROOKS. Which would make a total of 4 out of 7?

Dr. DOOLITTLE. Which would make a total of four, and this to me is optimum.

Mr. BROOKS. I think this is extremely important, certainly at the inception of the board that there be adequate representation from the military because the military has carried on the programs.

If by chance, and I do not expect this to happen, the board would be set up with a minimum representation from the military, which would be one under this bill, you might have a break in the military programs that have been carrying on in the past and not a continuity. That is true, is it not, General?

Dr. DOOLITTLE. Yes, that is possible.

Mr. BROOKS. In case we cannot get one representative from each service, plus the Defense Department, would you suggest as a preliminary matter for the first year or two that we have that number and after that make it optional?

Dr. DOOLITTLE. We certainly should start off with this new organization, with four people from the military.

However, the legislation is written in such a way to permit great flexibility and will permit it to change with the times as required.

Mr. BROOKS. A Reserve officer would not be military; he would be civilian, would he not?

Dr. DOOLITTLE. At the present time the representative to the NASA from the Defense Department is a civilian. The four representatives, 2 from the Navy, 2 from the Air Force, are senior Regular officers.

Mr. BROOKS. Would you consider yourself, for instance, a civilian or military, or both?

Dr. DOOLITTLE. I resigned from the Military Establishment in 1946. I did not retire; I resigned, so I am 100 percent civilian.

Mr. BROOKS. You are a civilian, that is the way I analyzed it.

I think it is extremely important that we move as quickly as we can to some sort of international agreement. How would you work that, though, General?

Dr. DOOLITTLE. International agreement?

Mr. BROOKS. Yes. You refer to that on page 2 of your statement. You say:

> The President and several Members of Congress have, I believe, clearly reflected the sentiment of our Nation by their proposals that weapons be barred from space by international agreement.

Have you thought of any procedure that you would use? Would you, for instance, go to the United Nations, or would you go to later called conferences? Would you go to the summit? What have you in mind?

Dr. DOOLITTLE. As an ex-military man, a technical man, and a businessman, with little or no knowledge of politics and diplomacy, I would say that question should far better be answered by someone more knowledgeable on the subject than I.

Mr. BROOKS. Regardless of the method used, you feel it is very important we have an agreement at an early date?

Dr. DOOLITTLE. Yes, sir.

Mr. BROOKS. The agreement, you indicate, should not be such as to prevent us from adequately defending our own country if that can be done?

Dr. DOOLITTLE. Mr. Brooks, I believe you bring up a question of international control of space.

Mr. BROOKS. That is right.

Dr. DOOLITTLE. This is a very difficult question indeed. Certainly we can take certain landmarks and we can say that we would not want enemy aircraft or spacecraft directly over the United States in a posi-

tion from which they could attack or not, but still in a position from which they could attack.

On the other hand, it is quite impossible to say that we own space out to infinity because it is over us because as our earth rotates we would sweep the entire heavens and you could not say who owned space.

But at some point certainly we should be able to shoot down any enemy craft that comes overhead.

Above that point, space, in my mind, should be international.

Now, where that point is, it is difficult to say. A few years ago it would have been impossible for us to shoot down anything over 50,000 feet. Now we can shoot down something comfortably at 100,000 feet, or 20 miles.

At some future date we should be able to shoot down potential military weapons at much higher altitudes, but for certainty at some altitude the space should be free and, I hope, there will come a time when at all altitudes will be free for peaceful purposes.

Mr. BROOKS. The altitude that you would specify would probably be an altitude that would be high enough to protect this country.

Dr. DOOLITTLE. That is right, as long as the threat of war exists.

Mr. BROOKS. That might vary from time to time as instruments are perfected?

Dr. DOOLITTLE. That is correct. You would expect that altitude to increase.

There, again, I could give only technical advice, not legal advice on this question, and it is an extremely complicated legal question.

The CHAIRMAN. I think you gave a very fine answer as far as I am concerned.

Mr. BROOKS. I think so, too. You have given an excellent answer there.

The CHAIRMAN. You have given the best answer I heard during these hearings.

Dr. DOOLITTLE. Thank you.

Mr. BROOKS. The doctrine of civil law is that a man owned just as far down as there was earth and as far up as there was any space over his property. That doctrine of civil law will be changed, however.

Dr. DOOLITTLE. Yes, sir; because you can only go 4,000 miles down until you come to the center of the earth, but you can go out a real far piece before you come to the edge.

Mr. BROOKS. I grant you that.

I want to ask you this question while you are here, General. We do not have an opportunity to hear or see you often, sir. Are you satisfied with the progress that is being made in the exploration and our scientific development of space?

Dr. DOOLITTLE. No, sir. I feel that this bill would permit a coordination of our efforts and would encourage greater effort, would encourage greater expenditures and would result in more rapid progress.

Mr. BROOKS. Wherein do you think we have fallen down in the past?

Dr. DOOLITTLE. In the past I do not believe the people of the United States, as a whole, have had an appreciation of the importance of space because it seemed as remote as Buck Rogers.

More recently, as a matter of fact, last October, we came to a sudden realization of the importance of space because somebody had gotten there before we did. Now, with a public awareness, I do not believe we have yet caught up with what it is possible to do with a well organized and coordinated effort. This is in progress at the present time.

I think we are in the process of catching up. But your question, I believe, was: Was I satisfied with where we are. No.

Mr. BROOKS. This will help us catch up?

DR. DOOLITTLE. Yes, sir.

Mr. BROOKS. How much money do you think we should spend yearly on the program?

Dr. DOOLITTLE. The amount of money we spend on this program is a compromise amount and I believe that we have to take into consideration our overall national income, our overall national budget, and many of the other things that are of interest to the people of the United States.

The CHAIRMAN. Including the necessities?

Dr. DOOLITTLE. Yes, sir.

Even under those conditions I feel that we should promptly increase our space budget. I believe Dr. Dryden has told you that the thinking was that the NASA in the first year would probably double the NACA expenditures.

In the next 4 years or 3 years, thereafter, it would quadruple it.

So we think of going from the present $100 million a year to $200 million a year, to $400 million a year. This permits an orderly program which Dr. Dryden and his people in collaboration with the military, are now endeavoring to work out.

Mr. BROOKS. That would be a 3-year program and up to $400 million?

Dr. DOOLITTLE. Yes.

Mr. BROOKS. That would not be a program of actually developing these spacecraft, would it?

Dr. DOOLITTLE. It would include the development of space craft. That is one of the new obligations.

In the past the NACA dealt primarily with planning and with research in flight. It was called an advisory committee, but almost from its inception that was a misnomer.

The new NASA will have those obligations and in addition is directed to develop a comprehensive program for civilian space flight and to develop tests and operate vehicles.

Also, they will have to contract on a much larger scale.

So we would expect that that extra money would be spent in those new obligations.

Mr. BROOKS. Now, your $400 million surely would not include the missile program, would it?

Dr. DOOLITTLE. No, sir.

Mr. BROOKS. Ballistic missiles and all of that would be different?

Dr. DOOLITTLE. The missiles program is strictly a military program. The reconnaissance satellite is strictly a military program.

Part of the program is strictly military; part of it is strictly scientific. Part of it is strictly research.

There is a fuzzy area in the middle that will have to be resolved, which is in the process of being resolved.

Mr. BROOKS. For what would you expend $400 million?

Dr. DOOLITTLE. That would be scientific, development, test, exploration, all of the civil space activities that are not directly related to the military.

Mr. BROOKS. All pure science would be included?

Dr. DOOLITTLE. Pure science would only be part of it.

Mr. BROOKS. General Doolittle, because you are so well known, the people of the country have so much confidence in you, I would like to have you tell this committee, how far you think the Russians are ahead of us in the development of the missile and the satellite program, if you think they are ahead, and in addition to what you have already said, what might we do to overtake and pass them?

Dr. DOOLITTLE. At the present time the Russians have put a much larger satellite in the air than we. They obviously have the first third of the ballistic missile further along than we have. That is the propulsion part.

The problem in ballistic missiles is in three basic parts: First, propulsion, the ability to shoot it where you want it.

Second, the guidance, the ability to direct it exactly where you want it to go.

And, third, the reentry.

We know the Russians are ahead of us in the first third of it. We do not know exactly where they stand on guidance and exactly where they stand on reentry.

We do know where we are. I would say that the Russians are ahead of us in the ballistic missile program therefore, and that it will require our very best efforts to catch up.

I believe those efforts are being expended. The present ballistic missile program is going ahead in very good shape.

As far as the satellite program is concerned, the Russians have put a much larger satellite in the air than we.

It will be some time before we will be able to put a satellite in the air as large as that of the Russians.

So I would say the Russians also are ahead of us in the satellite program insofar as their abilities to put a large satellite in the air is concerned.

On the instrumentation of the satellite, I do not believe they are ahead of us. I believe we have just as good scientific instrumentation as they.

However, Dr. Dryden can answer that question more intelligently than I.

Mr. BROOKS. Because the American people know you so well, I want to ask you one more question, and then I shall have concluded.

Since you feel the Russians are ahead of us in this respect, do you think that this fact that they are ahead of us in this development constitutes a definite threat to our security, our safety as a people, until we overtake them?

Dr. DOOLITTLE. I would rather, Mr. Brooks, put that on a somewhat broader scale, and say that the Russians have an arms and ammunition economy. They are working very hard and on those things to which they have directed themselves, they have been able to progress more rapidly than we. It is going to take our best efforts to keep ahead of Russia in those things that will keep us out of war and in those things which we as a nation require.

I feel that the solution of that is not merely the development of a space program. I think the development of a space program is an important part of it, but I feel that we in America have to become aware of the situation.

We must know more about international conditions. We must be willing to work harder and if necessary we must make some sacrifices.

Mr. BROOKS. Just one final question. I notice in the press in the southwest part of the country that rocket scientist Frederick G. Saumer said the other night in a speech down there that the Russians had taken 16 shots at the moon.

Where he got his information from, I don't know. Do we have any intelligence that you know of that they have been firing at the moon and missed the moon?

Dr. DOOLITTLE. I know of no such intelligence, Mr. Brooks; however, it is quite possible they could take a shot at the moon without our knowing about it.

However, you will remember that in my statement I said that we must have a comprehensive program of space research, space technology, and space exploration. And simply because the Russians are first in some particular phase of this should not necessarily cause us to change our program.

If they got badly ahead of us in an important phase, then it might be necessary for us to change. But I would say a shot at the moon by the Russians would not be sufficient to cause us to change a sound program.

Mr. BROOKS. We could not take a shot at it ourselves without the Russians knowing about it; could we?

Dr. DOOLITTLE. It is very difficult for us to do anything without the Russians knowing about it.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. When Dr. Dryden appeared before our committee, he pointed out the fact that the NACA is an operating agency and not an advisory agency.

This particular bill or a bill similar to this before the committee would also provide that the new agency would be an operating committee.

How long have you served as Chairman of the Board of the NACA, General?

Dr. DOOLITTLE. I have been Chairman of the Board for something over a year and a half.

Mr. NATCHER. The Board of NACA has 17 members at the present time?

Dr. DOOLITTLE. Yes, sir.

Mr. NATCHER. The provision in our bill, also, as you well know, calls for 17 members. Since you have served as Chairman, do you find that this size board is too large? Should this number be reduced from the standpoint of efficiency and having a good operating agency?

Dr. DOOLITTLE. I would like to answer that question, sir, by saying that the smallest board that will give adeouate representation to all of the Government and civil agencies involved is the most desirable board.

I believe that the number 17 accomplishes this purpose very well indeed. I would not recommend that it be increased even though some of the present governmental members will have to be removed,

if we go along with the idea of putting 4 military people on it, because that leaves only 4 spaces for other Government agencies.

Certainly the AEC should be on it. Certainly the National Science Foundation should be on it. Then there are only two spaces left. Certainly the Civil Aeronautics Authority should be on it. Then there is only one space left.

Then you begin to wonder what to do with that one space and possibly the Weather Bureau should have it because the Weather Bureau deals with the environment in which we operate certainly until we get out of the earth's atmosphere. So that is all of your eight spaces used.

Now, you have taken off the Undersecretary of Commerce who is presently on it. You have taken off the Secretary of the Smithsonian who is presently on it, and you have taken off the Director of the National Bureau of Standards who is presently on it.

So you say right away you would like to have three more spaces, but to have three more spaces you would, I think, get an unwieldy board.

Seventeen is a number with which we have dealt very successfully, and it seems to me the minimum that will permit us to have all of the representative disciplines and governmental agencies with whom we deal involved.

We meet once a month, on special call if necessary in addition to that, and we are able then to discuss with the Director his problems and there is somebody there who represents each one of the agencies outside of the NACA with whom he is obliged to deal

This has proved to be a very great help to the Director. However, perhaps I should not say that as Chairman. I think the Director would say it, however.

Mr. NATCHER. Another provision to this bill, General, provides that the Board shall meet at least four times each year. I believe the NACA organization has the same provision.

Dr. DOOLITTLE. It is the policy of the NACA to meet once a month with the exception of occasionally skipping a month in the heat of the summer and sometimes the Christmas month, if there are no particularly important things to act on.

However, they also meet for several days at the laboratories from time to time, if there are special jobs to do. My own feeling is that the Committee should continue to meet on an average of once a month, and to be ready to be called if the Director has a special problem that he would like to discuss with them.

Mr. NATCHER. General, as you know the bill presently provides that a director shall be appointed by the President and confirmed by the Senate. Considering your experience as Chairman of the Board of the NACA, what type of individual should be the Chairman of the new space committee? Should he be a scientist? Should he be a man from industry? What type of individual, in your opinion, General, should the new Director be.

Dr. DOOLITTLE. In my mind the new Director should, first of all, have an open mind. He should be a man who can accept and deal with new concepts. Next, he should be a technical or scientific man.

He should know technology or science. Better yet, technology and science. Next, he has to be an excellent administrator. Last of all, he has to be a good salesman because he is obliged to get the money, the facilities, the things that he needs to do his job.

Therefore, he has to be able to present his programs in a way that will make it possible for him to realize them.

Mr. NATCHER. General, if we declassified some of our materials, could we move forward a little faster?

Dr. DOOLITTLE. Would you repeat the question, sir?

Mr. NATCHER. The declassification of some of our materials. At the present time, how do you feel about declassification? We have had witnesses before this committee that definitely were of the opinion that we should declassify some of our material at this time.

Do you believe that could be done and it would help this program and other programs in the missile and outer space program that we are now in at the present time?

Dr. DOOLITTLE. In a general way, yes, sir; I feel there should be additional declassification. But whenever we deal with the military services and the work that we do has direct or indirect military application, I feel that that declassification or lack of declassification should come through the military.

The CHAIRMAN. You mean the military should have the control over the question of declassification?

Dr. DOOLITTLE. I mean wherever we do work specifically for the military, I feel the military should say whether or not it should be declassified, and not the NACA.

Dr. DRYDEN. May I inject, Mr. Chairman, that the NACA does have power to classify material originating in its own projects, if it seems desirable. We do classify documents and have a very active declassification program.

The average life of a classification is something like 3 years. General Doolittle is referring to work that we do specifically for the military. We work on the 110–A bomber. The declassification of that work comes through the military.

Mr. NATCHER. General, the NACA is quite an organization. I believe the organization controls and operates between four and five hundred million dollars worth of property and has 7,600 employees, approximately 4,000 of them scientists or men and women with the approximate qualifications of a scientist.

Now, General, since you have served and are serving as Chairman of the NACA, you know of the many hardships that have confronted your particular agency. Would you point out to this committee what the main obstacle is that has confronted your organization in the operation of this particular program since you have been Chairman.

Dr. DOOLITTLE. The Congress has been very kind in permitting us to have the money we require for new facilities. I would say that the fine work done by the NACA is largely the result of the excellence of its people. I would say that our greatest problem is the acquisition and retention of competent people.

Mr. NATCHER. General, thank you very much. I want to thank you for your fine statement and for your testimony before this committee at this time.

Dr. DOOLITTLE. Thank you, sir.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. General Doolittle, in view of your answer to Mr. Natcher's last question, I would like to discuss with you, on specific terms, your reason for advocating the new legislation which we have before us.

What primarily do you consider to be of paramount importance in the new legislation of the new Space Committee that is proposed to be set up under this legislation? What are the prime requisites over and above what NACA is doing at the present time?

Dr. DOOLITTLE. Did I understand you to say what are the prime things that the NACA has to have that it does not have now?

Mr. SISK. That is correct.

Dr. DOOLITTLE. Contract authority to contract with outside agencies. We presently have a very small authority and ability to contract. We do very little outside contracting.

This will have to be substantially augmented and is outlined in the bill. The other problem with which we will be faced, if a substantial part, let us say eventually half, of our work is done in governmental laboratories and half by contract laboratories outside of Government, is some way of equating pay between the people in the governmental laboratories and in the contract laboratories. That is covered by the bill.

Mr. SISK. Of course the thing that many of us have been concerned about is the actual need for a new agency that would really expedite and help to move ahead in the field which we are, of course, all concerned with.

It is my understanding that the NACA is at the present time doing substantial work in space research, which, of course, would be part of the new agency. You are doing some contract work. Do I understand that, legislatively, you are to closely limited with reference to contract authority under the present NACA, General?

Dr. DOOLITTLE. I will let Dr. Dryden answer that.

Dr. DRYDEN. At present we have contract authority to contract on special investigations with a limitation of $500,000 a year. This is the present contracting authority for research.

We, of course, do contract for construction, for equipment, in the usual sense. If I might supplement General Doolittle's answer, the two very new things are the authority to operate space vehicles, to acquire and operate these vehicles. The other is to undertake what we speak of as hardware development.

At the present time the NACA does not undertake the development of airplanes or missiles or engines. This law provides the authority to develop space vehicles.

Mr. SISK. That is the point I was attempting to pin down here, to try to determine exactly what, in addition to the present authority of NACA, is needed. It was my understanding that General Doolittle felt that the NACA should be the nucleus of the new organization and he mentioned that it would have, to some extent, the same group of people, and so on.

I think that becomes rather important because some of us have had some concern about what we needed to do, and whether or not we needed a tighter type of authority, for instance something along the line of a commission similar to the Atomic Energy Commission, rather than a large committee. That is why I was asking for specifics as to the reason why you were supporting the new legislation.

Dr. DOOLITTLE. I am satisfied that the NASA can take on its additional obligations with the changes that I suggested. You will observe that in the changes suggested that the Director is given

additional authority. He becomes the chief executive, so there is one chap responsible.

Mr. SISK. That, as I see it, General, is actually the greatest and the main change in the new legislation, the new position of Director which, as I understand, is entirely different from the method by which NACA proceeds. This Director would have susbtanial authority and would be able actually to operate, based on his own decisions, and the Board would only have authority to recommend or to advise. Is that in your understanding?

Dr. DOOLITTLE. That is my understanding and that is the way I believe the most rapid progress can be made in this field, by having straight-line responsibility and authority.

Mr. SISK. You would visualize, then, that the Director, with the power which he would have under this legislation, would report directly to the President. Is that right?

Dr. DOOLITTLE. The President might put, as an intermediary, his assistant for science and technology in; otherise he would report directly to the President.

Mr. SISK. I might say along this line, General, that this is a question which has been asked of almost every witness who has been before us, and that has to do with whether or not you feel that science and technology should have a place in the Cabinet today, whether or not we should have a Secretary of Science or Department of Science, or Department of Space Technology at the Cabinet level.

Dr. DOOLITTLE. I do not want my answer to seem facetious, but my feeling is very strong that we should do nothing to complicate our present system of Government unless there is a real reason for it, and I do not see a reason for this.

Mr. SISK. I can appreciate that it already is too complicated in many areas, General. I will agree with you on that.

The point, of course, in the minds of some is that we should place emphasis upon the feeling that maybe some years in the past we have not properly emphasized scientific and engineering know-how and development research and so forth.

Dr. DOOLITTLE. I agree entirely. In the past science and technology has not had a voice in the highest levels of Government. However, now, Dr. Killian sits in the meetings of the National Security Council.

He sits in all of those Cabinet meetings that deal with scientific or technological matters. He sits on other committees. He is the director-adviser on scientific and technical matters to the President.

So I believe that science now for the first time does have a voice in the highest levels of our Government; that is, the executive side of our Government, sir.

Mr. SISK. General, do you feel strongly about the possible failures in our educational system at the present time?

That, also, is the subject, as you know, that is receiving quite a lot of discussion now. There are certain criticisms of our educational system with reference to proper emphasis on mathematics, on science, and subjects of that kind.

Do you have any particularly strong feeling on that issue?

Dr. DOOLITTLE. Yes, sir. I feel very strongly on that subject and I go back to my original contention that the reason that the Russians

are picking up on us in some areas is because in those areas they are working harder than we are, not because they are any smarter.

In school they are working harder than we are. Even at the elementary-school level the students are working harder than ours. I feel that in elementary school we should start the youngsters working harder, and that they should learn some discipline, more than they are presently learning in the elementary schools.

In the secondary schools I believe we should have more classrooms, more teachers, better teachers, particularly better science teachers, so that those students who wish to study science can.

In the colleges I believe we should have professionals turned out who are not only good lawyers, good engineers, good doctors, but also who are good American citizens.

For that reason, I feel they should have some of the humanities. By the humanities I do not mean Latin and Greek, but learning something of history, of geography, of government, of other peoples of the world, and how they live.

I feel that our educational system needs an overhaul from top to bottom.

Mr. SISK. General, I am inclined to agree with everything you have said, but let me ask you this further question without any attempt to put you on the spot. Do you have any recommendation that you could make to this committee or to any other committee of the Congress as to what might be done to correct that situation?

Dr. DOOLITTLE. I would like to see the Federal Government take the lead in improving our school system and I believe one of the things they can do is to appropriate more money for that purpose.

Mr. SISK. Do you feel that the lack of proper pay or salaries for our teachers all the way from the primary grades clear through to the universities has been a detriment?

For example, industry can pay a top scientific man, who might be an excellent teacher in a university, 2 or 3 times what the university can. Do you feel that has any influence?

Dr. DOOLITTLE. I would like to answer that in part in connection with a question you asked earlier about the Russians. I would not suggest that we follow the Russians except in our ability to work a little harder than we are working.

But the Russians have done two things which we have not done in their school system. First, they have given an incentive to the teacher to remain with teaching. For instance, a top scientist teacher in Russia gets 50 times as much as a laborer. Here, some teachers do not get as much as a laborer.

This, I feel, is basically wrong. It is a fault in our system that we should correct. The other thing is that in Russia premium is put on intellectual capability as well as athletic capability. So the youngster, when he gets to the top as a good student, is given prestige commensurate with his intellectual capacity.

Here, we are inclined to give to my mind too much credit to the athletic prowess of a student and too little to his intellectual capability.

Mr. SISK. Thank you, General. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. General, we are very glad to have you here because we Americans look to you as a very distinguished American and one who has contributed much to our country.

You have read the comments now and have read the legislation about the need for a new space program. In your considered judgment, is a new Space Agency necessary, to be set up by the Federal Government and recommended by this committee to the Congress. Must we have a new Agency?

Dr. DOOLITTLE. I believe that this is the best way to accomplish our agreed purpose, and that is to get on faster with space science and space exploration.

Mr. FULTON. That means that the present facilities, while they are adequate for the current programs and have made wonderful progress, are not adequate for the expanded national space program that this committee is developing?

Dr. DOOLITTLE. The present facilities of the NACA are presently being utilized in part for work directly or indirectly related with space activity. But in the new organization these facilities would continue to be expanded and augmented gradually, but the new organization would also take on contractual authority to run other laboratories and this it does not yet have, and this is an important part of the overall.

Also, the job of the new agency, which is not being done, or could not be done with the present charter of the NACA, is to develop a comprehensive program for all civilian space activities.

Mr. FULTON. That brings up the question as to the extent of the authority of the proposed new National Space Agency. Should it be both a research and development agency as well as an operational agency?

Dr. DOOLITTLE. Yes, sir.

Mr. FULTON. Would you have this new Space Agency continue the maintenance of laboratories, the manufacture of particular space vehicles, and hardware for the purpose of a space program?

Dr. DOOLITTLE. I would have it maintain laboratories for research, some development. I would have all manufacturing done by industry.

Mr. FULTON. In the bill which the chairman of the committee, Mr. McCormack of Massachusetts, has sponsored on behalf of the administration, there is the name of the new proposed Agency set out on page 3, the National Aeronautics and Space Agency. May I just comment on that name.

The name as proposed is a mixture to me on the one hand of both a method of navigation, aeronautics, and on the other hand, a place, so that the two adjectives are not the same type.

I would like to see the Agency called the National Space Agency or else the National Space Agency for Research, Development, and Exploration, or, if we consider the method of navigation, we would call it the National Aeronautics and Astronautics Agency, or if we talk only of the place alone, then we would call it the National Air and Space Agency.

But we should not confuse the method of navigation with the place where the operation is to occur. Do you agree?

Dr. DOOLITTLE. Mr. Fulton, I do not think the name of this organization is particularly important. I do feel that the NACA has come to have a connotation in the minds of industry and governmental people associated with aviation.

Many of these same people are going ahead right out of the air and into space. The NASA is only a slight change in name and probably would have the advantage of continuing to remind them of the excellent past in the history and the tradition of the NACA.

But whether it is called the National Aeronautics and Astronautics Agency, or whether it is called the National Aeronautics and Space Agency to me is not a particularly important thing.

Mr. FULTON. But to the public and to the world it will be the question of whether we are simply continuing the NACA, the National Advisory Committee for Aeronautics, under a slightly expanded form or whether we are starting out on an entirely new broadened program with the aeronautics purposes as simply a part.

Does that have any bearing on your thinking?

Dr. DOOLITTLE. Mr. Fulton, two things have been done that I think are important in this new title. One is to get rid of the word "advisory" which is a misnomer, and the other is to put in the word "space" which, to me, overcomes the problem that disturbs you; and that is, it means we are not now strictly dealing with aeronautics but have gotten out into astronautics.

I am perfectly satisfied with the name. I would be perfectly satisfied with the change in name, and I feel that the results of this new Agency will soon prove it.

Mr. FULTON. We on this committee, I am sure, want to recommend the establishment of a space agency that will have a broad field of activity, and not be bound by possible previous limitations.

When the administration first sent up the Marshall plan it was called the military aid program. It was my amendment, I am very glad to say, that turned it into the mutual defense assistance program, putting the word "mutual" into it.

That word "mutual" I have heard used many times in speeches, but it means mutuality in defense and assistance. The question on this is; should we just simply expand the name a little of the present NACA and expand the functions of NACA a little or should we put this National Space Agency into an entirely new frame of operation, an entirely broadened field, and with a tremendously accelerated program? Which do you recommend?

Dr. DOOLITTLE. I recommend the present bill. I recommend an accelerated program that is a well-coordinated and well-thought-out program. I do not believe that it is desirable to go into a tremendously accelerated program until we know just where we are going, it is a problem of semantics here.

Mr. FULTON. It is largely a degree of magnitude whether simply to increase and accelerate current programs or to embark immediately on the research and development and basic scientific study; for example, in the field of the ion engine, photon propulsion, the solar energy propulsion, the development of the one-third of a million pound thrust engine, the million-pound thrust engine, the million and a half pound thrust engine, the development immediately of a program for a manned space ship, for exploration of outer space, or of the moon, the development of programs that will look into the chemical radical changes that will permit us to use the upper level of oxygen, for example, for space vehicles at a 60-mile level.

If we look at the program in that relationship it is a tremendously expanded program in addition to the ordinary improvement of the useful performance and safety of airplanes.

Dr. DOOLITTLE. I believe all of the programs you have suggested should be explored; that money should be spent on those according to their likelihood of prompt realization.

I do not believe that we should go, for instance, into an extensive development of the ion propulsion system at this time. I believe we should continue to do research on it and get as much information as we can and we should even do some development.

You know much more about the ion system than I do, but to me it is something that will be extremely useful but at great distance and over long periods of time.

The first job that the NASA has been asked to do is to outline a program. This comprehensive program can be a program that will take a great many billions of dollars per year or it can be a program that will grow gradually to whatever science indicates are useful things to exploit. That is the program I would like, the latter one; that is, an accelerated program, but not a crash program.

Mr. FULTON. Dr. Van Allen had recommended a program to begin with in the magnitude of a half billion dollars a year to start. Is that larger than you are thinking of personally?

Dr. DOOLITTLE. If we were given a half billion dollars and told to spend it effectively, it would be very difficult to spend that in the first year. We could probably allocate it in the first year and spend it over a period of time.

Mr. FULTON. But with a good practical vision you could make plans if you knew you were going to get, under NACA expanded to NASA, sums of money that would permit you to develop at the rate of a half billion dollars as you moved into that level?

Dr. DOOLITTLE. That is correct, and I would certainly want to start the one-third of a million pound rocket study at once.

I certainly would want to study the million-pound rocket study at once. I would delay the million and a half pound a little to see how the others were going but phase it in as required.

Mr. FULTON. As a matter of fact, the lifting of weight has in and of itself no particular practical gain at the present time since advanced instrumentation, guidance, and engines are not prepared.

Dr. DOOLITTLE. The program must go forward on a company front. It is not desirable to work on one thing and get way out ahead so that the things that support it are way behind. That is why we must have a coordinated program.

Mr. FULTON. On the million-pound-thrust engine, so far Congress has given money at the rate of about $500,000 annually. Is that not correct, Dr. Dryden?

Dr. DRYDEN. That is the present expenditure for study.

Mr. FULTON. On the million pound thrust engine it would probably run, as an educated guess, maybe $200 million to complete a project of that type.

At the present rate of study and expenditure by Congress it would take us 400 years to come to a million pound thrust engine.

Would you recommend that our program and our basic study on the million pound thrust engine be greatly expanded? For example, should $15 million or $25 million be allocated so that the planning study be done, not expended all at once?

Dr. DOOLITTLE. I would see this as an exponential curve by which at the present time we are spending a little money, which is all that is required to make the study and learn more. As you learn more you can spend more money.

It would not be $500,000 a year for 200 years. It would be an increasing amount until at the end of 5 years you would have your project completed.

Mr. FULTON. You would then plan for the expenditure of maybe $150 million to $200 million for the million pound thrust engine for the next 5 years?

Dr. DOOLITTLE. If that is the time that the technical people say it will take to produce that.

Mr. FULTON. You have spoken of a civilian agency to exercise and implement, both on the research and development and operating basis, the national space policy.

Why not have that Space Agency have the full jurisdiction of all space activities, including both civilian and military?

Dr. DOOLITTLE. I believe the military have specific problems that are characteristic of the military and that they must control in order to do their job. One of those is immediately the missile program, the intermediate range and the intercontinental missile.

Those are strictly military and I believe they should be under the military. Another is the reconnaissance satellite.

Now, when you come to the weather satellite or satellite used in communications, then there is a fuzzy area whether they are military and civilian because both the military and civilian benefit from it.

As I said when I started, to me there are some things that are strictly civil. They should be done by a civil agency because the military would have less interest in them than they would in strictly military things.

However, the things that are strictly military should be done by the military or the agency which required them. In the middle there is a fuzzy area which has yet to be resolved.

Mr. FULTON. Do you agree with Dr. von Braun that we should proceed immediately with a program to launch a missile to propel a man 150 miles into space? Is that worthwhile and practical to you?

Dr. DOOLITTLE. I believe that program should be evaluated along with all of the other programs, and see whether it fits in as a useful part of a comprehensive plan.

Mr. FULTON. With reference to the manned vehicles that will enter outer space shortly it is a problem of both astronautics, guided missiles, as well as short-time space.

That brings up this question: Should that be completely military, or should we say, "Look, we are going to look ahead to the time when we will transport passengers between New York and London in one-half hour or we are going to be able to get these vehicles in the air as freight carriers for civilian purposes."

Dr. DOOLITTLE. I do not believe that the development of space travel should be strictly military. Certainly it has a military application. This is one of the things in the area that might well be a joint operation.

Mr. FULTON. Then why not give one civilian agency such as the National Space Agency the control of the policy and then put in that Agency the operations on a civilian basis, and put in the military, the Department of Defense, the operations on a military basis with some sort of liaison military committee to work out as they progress the fuzzy or the jurisdictional areas where they might overlap?

Dr. DOOLITTLE. I believe that at the present time that is substantially what is done with ARPA handling the military part, and with the thought being that the NASA would handle the civilian part.

Mr. FULTON. You do now have a jurisdictional committee operating with ARPA, do you not, to decide between NASA, CAA and ARPA, settling the questions regarding operations and research and development field?

Dr. DOOLITTLE. That is correct.

Mr. FULTON. Let me read the provisions of the statute of the proposed bill:

> The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States * * *

I am reading on page 2. The provision then goes further and says, and I refer your attention specifically to this provision:

> * * * except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense.

The words that are of particular significance are,

> may be peculiar to, or primarily associated with, weapons systems or military operations.

In your opinion, will that language limit too closely and be too severe on an agency like ARPA in the Department of Defense so that it will not be able to have a broad enough field to conduct basic research and continue a good many of the basic research programs that are already operating under it?

Dr. DOOLITTLE. The interpretation of that particular phrase will be the determinant. I believe the military services do need to do some research or have some research done for them. They must have the results of basic research.

Mr. FULTON. Because this language is indefinite and Dr. York has interpreted it one way and others have interpreted it more broadly, and with the fears that there might be some restriction in this language, would you at this point in the record and at your leisure submit a form of language that is nontechnical that will outline the necessity of keeping basic research in ARPA?

I want to make sure it is kept, so could you give us something that, in your opinion, will settle the trouble and indefiniteness of this language?

Dr. DOOLITTLE. You want me to write that and send it to you?

Mr. FULTON. If you will, for the record.

Dr. DOOLITTLE. Yes, sir.

Mr. FULTON. That is all. Thank you.

(The information above referred to is filed with the committee.)

The CHAIRMAN. Gentlemen, I will have to leave shortly because of my duties as majority leader.

So with the permission of the other members I will ask you a few questions at this time.

Mr. Fulton called your attention to page 2:

> The Congress further declares that such activity should be directed by a civilian agency.

"Should" is a sort of cloudy word, a word of qualification. Should that not be "shall"?

Dr. DOOLITTLE. I believe that is the intention.

The CHAIRMAN. Now, on line 7, it says: "except". Now when you get to the word "except", that is a pretty broad word. It is a sharp word—"in so far as such activity may be peculiar to, or primarily associated with, weapons systems", and so forth.

I thoroughly recognize the importance of the military and I am for it very strongly in the world of today. But with language like that, if the military says that any activity falls into the intent of the word "except", and is primarily peculiar to or primarily associated with the military, and on the other hand, the new Space Agency takes a contrary view, then under this language would not the position of the military prevail?

Dr. DOOLITTLE. I have no objection to the language, Mr. Chairman, and I am satisfied that a proper interpretation of it can be arrived at.

The CHAIRMAN. In other words, instead of the word "except", insert "provided, however, that insofar as such activities may be peculiar to or primarily"——

Dr. DOOLITTLE. I would have no objection.

The CHAIRMAN. Yes, words along that line.

I think we have a meeting of minds. We are practical men and we know that after an Agency is established, there will follow practical administration. I am aware of that.

The questions that all the members have asked are good questions for the record, but the real solution to our problem is to be by the type of administration.

Now, I notice there is no qualification prescribed for the Director. There are qualifications prescribed for the non-Government members of the Advisory Board, but there is nothing in the statute prescribing what type of qualifications the Director should possess.

Do you think that the committee should address itself to that? What do you think, Dr. Dryden?

As far as I am concerned, you are not to judge my state of mind by the question.

Dr. DRYDEN. I would see no objection to putting in the sort of qualifications that have been talked about, to qualify him in science and technology and administration.

The CHAIRMAN. One may not be a scientist and yet could be a top administrator. I note there is nothing indicating the qualifications of the Director who will be the topman in this bill in its present form, should it be enacted into law, but there are qualifications prescribed for nine of the members of the Advisory Board.

Now, on page 4, I call your attention to the paragraph (b) at the bottom:

> The Board may make recommendations to the President with respect to the appointment of the Director and the Director shall not be appointed until the Board shall have a reasonable opportunity to make such recommendations.

Is that not somewhat of a limitation of the powers of the President of the United States, that he cannot act until some action precedent takes place?

We know the setup with regard to the constitutional position of the President which we have to respect. I assume he would not act without seeking recommendations, but to prescribe that condition as precedent in the law——

Dr. DRYDEN. That was merely quoted from the present National Science Foundation Act. That is the source of it.

I do not remember any specific discussion of it other than they would lift this language from the National Science Foundation Act.

The CHAIRMAN. You do recognize that is a condition precedent to the exercise by the President of the power and duty that he inherently possesses by reason of being President.

Dr. DRYDEN. I would think the same purpose would be accomplished by ending the sentence after the first "Director," the Board may make recommendation.

The CHAIRMAN. I am not posing any objection. I am seeking information.

On page 5:

The Board shall be consulted by the Director.

Now, we are creating a complete organizational setup that is different from the present NACA. Under the present NACA, the Advisory Board is the governing group if they want to be. That is correct; is it not?

Dr. DOOLITTLE. That is correct.

The CHAIRMAN. Now, the Director is at the top?

Dr. DOOLITTLE. That is correct.

The CHAIRMAN. "The Board shall be consulted." If we have this theory of responsibility that is advanced for the appointment of a director, should that not be "The board may be consulted by the Director"?

I assume a wise director would consult the Board, but I am talking about reading into the law now. I think it is well to have any individual man surrounded by good, sensible advisers. I recognize his responsibility, but I recognize how important advice is to those who have responsibility.

I know that from my own position in the Congress of the United States. I am constantly seeking advice. As the majority leader I make decisions, but I am constantly seeking advice of the other Members on legislation coming out of a committee, and in various ways.

Dr. DOOLITTLE. Mr. Chairman, the Board is both a protection for the Director and a group of people who endeavor to assist him in his work. I would much prefer to have the Director himself answer that question.

My own feeling is that it would be better for the Director if he were obliged to consult the Board.

The CHAIRMAN. Then that takes the Board out of an advisory capacity?

Dr. DOOLITTLE. No; if it was not advisory he would be obliged to take the advice.

The CHAIRMAN. He would be an unwise director if he was supposed to do it and it was mandatory and he would not do it. I would not want to be a director under a law that says the Board shall advise and yet I do not have to accept its opinion.

Dr. DRYDEN. I think, Mr. Chairman, the word which causes the most trouble is "prior to" at the end. If it read that: "The Board shall be consulted by the Director on certain matters" without tying it to specific actions of the Director, this would not be a limiting feature.

The CHAIRMAN. I think there is a lot to that.

What do you say, General Doolittle?

Dr. DOOLITTLE. Anything that makes the Director happy makes me happy, Mr. Chairman.

My only interest is to make this Board as useful as it can possibly be to the Director.

The CHAIRMAN. I want to have this a real advisory board if we can keep it in the bill. We are sold on a "bill of goods," so to speak, on the question of responsibility, and if we are going to have responsibility we want to place it definitely.

You think striking out the words "prior to" is sufficient?

Dr. DRYDEN. Yes.

The CHAIRMAN. These questions are simply to inquire for the benefit of myself when we are in executive session.

Now, it also provides on page 4:

> The Board shall make an annual report and from time to time such other reports to the President as it deems appropriate.

This means that the Director makes reports to the President and the Board shall make an annual report and, from time to time, such other reports. That puts in the organizational setup the Director, and then you have the Board making reports also directly to the President. What about that?

Dr. DOOLITTLE. It would seem to me about the only thing that the Board would report would be that it did not like the Director, or question the manner in which he was doing his job.

There is presently, as you know, a report made. That is made to the Congress through the President. Now, there will be two reports made. One by the Director to the Congress through the President, and this will be a report which the board may make to the President, giving their indication as to how the job is going which is in substance how the director is doing his job.

The CHAIRMAN. Well, should not the language be such that the Board shall be required to make reports, and so forth, through the Director, the line of command?

Dr. DOOLITTLE. No, sir; I think that would defeat the purpose of this.

Dr. DRYDEN. I have not consulted the Chairman on this, but I think I suggested before that if that sentence or requirement were omitted the Board would make whatever reports to the President they felt necessary without having a requirement that they make reports once a year.

Dr. DOOLITTLE. I would be happy with that.

The CHAIRMAN. Will you repeat that again?

Dr. DRYDEN. Eliminate the whole sentence, then the Board will make whatever reports it thinks necessary; that it is not required to make an annual report.

The CHAIRMAN. Also put a period after the word "director" on line 23?

Dr. DRYDEN. Yes, sir.

The CHAIRMAN. Doctor, I am going to address a question to you. I listened to you on Meet the Press Sunday night. Often times on programs of that kind we Members of Congress get more information than we do otherwise.

Dr. DRYDEN. They won't like your characterization of the program. It was Face the Nation.

The CHAIRMAN. That is right. I have been on that program several times.

I notice that the program has a habit of getting you big dignitaries.

In the course of it, you said negotiations and discussions are now underway with ARPA in connection with the transfer of activities which may come within the twilight zone that the General has so well described.

Are you in a position now to enlighten the committee as to what the discussions are? If not, I do not want you to.

Dr. DRYDEN. I was going to put in the record a statement as to those negotiations. They are not completed as yet, but I can make a progress report and I can get that to you, Mr. Chairman.

The CHAIRMAN. That will be perfectly satisfactory, Doctor.

(The information referred to follows:)

MAY 12, 1958.

Hon. JOHN W. McCORMACK,
Chairman, Select Committee Astronautics and Space Exploration,
House of Representatives, Washington, D. C.

DEAR MR. McCORMACK: During the hearings before your committee, when I appeared as a witness, the request was made that I submit a statement regarding the status of negotiations between the National Advisory Committee for Aeronautics and the Department of Defense.

Attached is such a statement.

You also requested that I submit a statement regarding the qualifications of the Director of the proposed National Aeronautics and Space Agency. I believe he should be experienced in science or technology and in the administration thereof.

Sincerely,

HUGH L. DRYDEN, *Director.*

STATEMENT REGARDING NEGOTIATIONS BETWEEN NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS (NACA) AND ADVANCED RESEARCH PROJECTS AGENCY (ARPA), DEPARTMENT OF DEFENSE (MAY 9, 1958)

As agreed upon between the Department of Defense and NACA, the initial program for NASA will provide for major effort in three principal areas of interest as follows:

(1) Effective use of unmanned space vehicles instrumented to collect information of value to the scientific community including properties of the upper atmosphere and outer space that affect flight and influence terrestrial phenomena such as weather and communications.

(2) An orderly development of the science, technology, and equipment required for manned space flight. Flights of a man in satellites or on more extended missions are not contemplated during fiscal year 1959, but laboratory and flight investigations including animal experiments to establish the principles by which manned space flight will be accomplished must be undertaken now with great urgency.

(3) Research and development on advanced components and new techniques will be emphasized to provide a continuous increase in the national capability in space technology. Unmanned satellite flights and elementary lunar probes are being accomplished with existing rockets, auto pilot, guidance systems, and structures developed as a part of the ballistic missile program.

As more difficult space missions are attempted they will require even larger and more sophisticated rocket systems, more accurate guidance systems, and auxiliary power systems for long duration flights New tracking, communication, and surveillance systems will be required for both ground and flight use.

In implementing the program, the existing launching area at Cape Canaveral and the proposed Missile Test Center at Camp Cooke will also be used for launching of space vehicles. New facilities will also be required. The NACA range at Wallops Island is to be equipped for the launching of small satellite vehicles

and for the subsequent monitoring and tracking of the flights. Instrumentation at the island will be expanded and improved as required for the expanded program.

New rocket test facilities for research on larger high energy fueled rockets will be required and these will be located at the rocket test center at Edwards Air Force Base.

The existing tracking facilities used in the IGY program will be developed and additional tracking sites will be established at latitudes north and south of the existing sites for tracking satellites on polar orbits. Additional tracking, instrumentation, and guidance stations will be required for flights in equatorial orbits. Some portable launching, tracking, and instrumentation stations will be constructed for use in special probing flights from widely dispersed locations.

Ground facilities for the development and evaluation of flight guidance and control systems will be constructed. The equipment will be investigated in a ground environment simulating as closely as possible that of space.

Military programs.—Programs that are predominantly military include reconnaissance and surveillance, countermeasures against space vehicles and jamming, special weapons effects in space, navigation aids, and space surveillance in connection with early warning and defense.

Civil programs.—Programs that are primarily civil include unmanned space flights to obtain scientific data such as vertical probes, lunar and interplanetary probes, scientific satellites with associated data acquisition and analysis.

Programs under discussion.—Programs still under discussion include man-in-space programs, the million-pound-thrust engine, and special purpose chemical engines, communications, and meteorological survey and research.

(Dr. Dryden also submitted the following material:)

Face the Nation

As broadcast over the CBS Television Network, April 27, 1958, 4:30 to 5 p. m.; CBS Radio Network, April 27, 1958, 9:30 to 10 p. m.

Guest: Dr. Hugh Dryden, Director, National Advisory Committee for Aeronautics.
Moderator. Stuart Novins.
Panel:

John Madigan, Chicago American.
Charles von Fremd, CBS News.
Jack Raymond, New York Times.

Producer. Ted Ayers.

Mr. Novins. A new civilian space agency has been proposed by President Eisenhower: It would be responsible for all civilian space science development and exploration. Secretary of Defense McElroy has told Congress that the man who is expected to be named as Director of this new agency is Dr. Hugh Dryden, who is currently Director of the National Advisory Committee on Aeronautics.

Dr. Hugh Dryden is here now to Face the Nation.

Dr. Dryden, the world is on the threshold of the space age, and if all goes as indicated, you will be the man probably with the key to perhaps the biggest door. We want to know what is behind that door and how you intend to walk through it.

So if you are ready, sir, let's take the first question from Mr. Madigan.

Mr. Madigan. Doctor, we are already spending billions of dollars and plan to spend billions more in military and research pursuits. Is this space race worth the cost?

Dr. Dryden Mr. Madigan, I think it is a cost that we will have to bear for the economic and military future of our country and the free world.

Mr. von Fremd. I wondered, Doctor, going along with this matter of costs, is there any pressing reason from the military standpoint right now why we should beat Russia to the moon.

Dr. Dryden. I think the aspect of the race with the Russians that we should think of is to think in terms of the analogy of an Olympic meet in which there are a very great many events. I don't think that even our country has the money to do everything possible that we can think of to do in space. What we must do is to demonstrate the capability to do any of these things.

Now, a flight to the moon does demonstrate certain capabilities in the way of rocket boosters, in the way of guidance equipment, which show that we would have the capability to do a great many other things as well.

Mr. RAYMOND. Are you suggesting, Doctor, that it would be sufficient merely to show that we can do this and not go ahead and do it, not build a base on the moon, not to try to circle the moon?

Dr. DRYDEN. I hope I am not misunderstood this way. We must choose the things which seem to be the best goals for our country, and not think that we have to follow everything which may be suggested by the Russians.

Mr. MADIGAN. Doctor, some witnesses up on the Hill have taken the stand it would probably be worthwhile to let the Russians accomplish it first. I think the term they used would be like adding something to Siberia, that it would be useless, and the cost to them would possibly help us in a general way.

Dr. DRYDEN. I think the difficulty with this idea is that we do not know that it will be useless We do not know what the results of such exploration will be. I compare it with Columbus setting out from Spain. He set out for a very different purpose from that what he accomplished.

Mr. MADIGAN. Can you place a pricetag now, looking long range into this unknown, as to what the cost will be?

Dr. DRYDEN. It is very difficult to fix an overall pricetag. I think we can say that unless we are willing to spend some hundreds of millions of dollars consistently over a period of years, we will not be able to accomplish very useful results.

Mr. NOVINS. When you say "over a period of years," Doctor, how do you place a limit? How do you ever stop, once you start?

Dr. DRYDEN. Well, have we stopped in aeronautics from beginning with the Wright brothers airplane? I think we are beginning a new age of space. I do not think we are going to accomplish all these wonderful things all in a moment, but we are beginning on a long road, and I don't, myself, look for the expenditure in this area to ever cease. I think we will have commercial applications of space.

Mr. VON FREMD. Dr. Dryden, you say that it is important that we show that we have the capability of reaching the moon. Dr. Wernher von Braun has said we must learn to creep before we walk.

Dr. DRYDEN. Yes.

Mr. VON FREMD. And walk before we run, and therefore has suggested that we send a man 150 miles up in space.

Dr. DRYDEN. Yes.

Mr. VON FREMD. I understand, however, sir, that you feel that this would be tantamount to, say, shooting a woman out of a cannon. How can you bring these two points of view together.

Dr. DRYDEN. Yes, I think the remark was taken a little bit out of context and was not addressed specifically to Dr. von Braun's proposal. There have been many similar proposals including some from within the NACA.

The problem is this. We must set ourselves a goal which is further away and more important than that. What I said was to shoot a man from the air vertically and bring him back by parachute contributed only a relatively small amount of information. We get a few minutes of weightlessness for the human occupant, compared to a little less than a minute we now have. The one who plans this program to get man in space, which I would define as man in orbit, has to consider whether the expense of this particular step is worth the cost, whether it contributes enough in knowledge.

We know, for example, that it contributes very little to the reentry problem because the reentry from satellite speeds in space starts at 18,000 miles an hour, or more, whereas the man here comes to rest and starts from zero, under conditions that are quite different.

Mr. VON FREMD. And you still feel Dr. von Bruan's proposal really does not have sufficient scientific weight?

Dr. DRYDEN. Dr. von Braun proposed this as part of a very extensive program which would cost on the order of a billion and quarter per year as I recall it, and I think the problem will be, having known what you are going to have available to accomplish your goal, whether you want to spend your money this way or whether you want to take a step which is a little further in advance.

The next step is to toss the man like the ballistic missile warheads down on Florida and to actually reproduce some of the latter part of the reentry conditions.

Mr. RAYMOND. Dr. Dryden, I would like to raise another question. A great deal has been said about the necessity of civilian control of space programs. Now why is civilian control so necessary? After all, the military put the satellites up. The military conduct most of the space work and probably have the first need for some of these space vehicles.

Dr. DRYDEN. If I could remember the various points, one of the points is the fear that the scientific aspects of space, the use of satellites for the scientific investigation of the universe, will not receive very much attention within the military group.

The second is the announced desire of the President to undertake international peaceful activities in space, and many people feel that if we start with an organization in Defense, it will be very difficult to arrange any international peaceful activities in space.

Mr. RAYMOND. I am not thinking in terms of the organization you have. I am thinking in terms of the control itself. There is an implication that the military now is not controlled by civilians And besides this point that you make about the military not paying attention to the pure science of it, well presumably they did when they got the satellites up.

Dr. DRYDEN Well, the proposal before the Congress is not that a civilian control all aspects of space work. The military aspects are still in the hands of the Department of Defense, and in my opinion there will be a great many projects which are of concern to both military and civilian use. Take communications as one. And in many of these areas I think there will be cooperative projects.

Mr. RAYMOND How do you have a cooperative project if the military has most of the operational need?

Dr. DRYDEN. Well, we have several such projects. The X-15 is a cooperative project with the Department of Defense in which our organization has technical control, the preliminary laboratory experimentation, sat in jointly on decisions as to the contractors to be selected, and we will obtain that airplane and fly it. There will be both Air Force and civilian pilots flying this airplane. This is an example of a cooperative project with the military which has been very successful. The X-1 airplane, all of these have been cooperative with the military.

Mr. NOVINS Doctor, the language setting up or proposing this new agency seems to be a little bit vague as to the organization, the function and the purpose of the agency. How do you visualize the organization of it? What will it comprise.

Dr DRYDEN Mr. Novins, the bill provides for a director as the chief executive officer to be appointed by the President with the advice and consent of the Senate. It provides for an advisory board of 17 men of whom 8 should be, not more than 8, from Government agencies.

The object of it is to bring to bear the experience of persons in other Government agencies who have interests in this problem, to bring in experience in the many fields of technology and science and public affairs that are concerned with the space problem.

Mr. NOVINS. As you see it now, Doctor, what current needs does this fill? Why isn't the present structure of research sufficient? Where are the weaknesses now that this new agency will attempt to correct?

DR. DRYDEN. At the present time the space satellite program will terminate at the end of the International Geophysical year. There is no provision to support the development of the scientific apparatus for making measurements in space.

Mr. NOVINS. But you have an existent organization, Doctor, do you not?

Dr. DRYDEN. We have an existent organization, but the scientific organization would normally go out of existence without any funds

Mr. NOVINS Why do you need a new agency? Why can't there simply be a request for new funds?

Dr. DRYDEN. I don't know Whether I understand exactly what is implied by the question. It is quite possible to set up all space work under the Department of Defense

I have tried to cover the reasons that have been stated for separating out the civilian aspects from the Department of Defense, and there have been proposals as you know, for a completely new agency.

What the bill provides is a new agency, but using as its nucleus a collection of people, facilities, facilities valued at some $400 million, $350 million, about 2,000 scientists who have been working in teams in these areas for a long time.

Starting with that building block, it is proposed to add by contract operation the people Who are now engaged in this program. It is a means of integrating and bringing together the people concerned with the space science and civil side of the space problem.

Mr. MADIGAN. Doctor, there is some support on the Hill for a commission form of control.

Dr. DRYDEN. Yes.

Mr. MADIGAN. A 5-man commission, 7-man like the AEC.

Dr. DRYDEN. Yes.

Mr. MADIGAN. Rather than a director and a 17-man advisory committee.
Dr. DRYDEN. Yes.
Mr. MADIGAN. Would you oppose a commission?
Dr. DRYDEN. Mr. Madigan, I have testified before the House committee on this subject. I have said I felt that that form of organization gives rise to a great many problems which comes from trying to define the relative responsibilities of 4 or 5 men who are running a single agency.
Mr. MADIGAN. You mean then that a 17-man advisory committee wouldn't be unweildy?
Dr. DRYDEN. The 17-man committee is purely advisory. The director is the principal executive officer, and the purpose of the advisory committee is twofold.
One, to strengthen him before outside agencies, other agencies, if they believe that the program is sound. Second, to protect the President and the Congress by having people who know all aspects of the subject to monitor the operation of the agency.
Mr. MADIGAN. Where in this world do you believe would be the best point from which to launch a space station of some sort?
Dr. DRYDEN. The problem of the launching of satellites, of course, is already solved. You can launch a satellite from Patrick or Camp Cook. There is a slight disadvantage in that launching from Patrick. We cannot launch into polar orbits, and the satellite track moves over the surface of the earth, so, for example, if you wanted to send a man around an orbit once, he wouldn't come back over Patrick. He would come back somewhere else.
Now as you look into the problems of particularly interplanetary probes, it is true to some extent for lunar probes, but not quite to the same extent, you must get a station on the Equator or very near the Equator. The problem is exactly the same as the intercept problem in aerial warfare, shooting from one airplane to another, where it is much simpler to shoot straight ahead and don't try to shoot off at an angle. Launching at any other point than the Equator amounts to shooting at an angle with a very complicated guidance system, and it increases the guidance requirements very greatly.
Mr. VON FREMD. Dr. Dryden, I would like to go back to this previous matter of this new structure, this new agency the administration is requesting. As I understand it now, your present organization, NACA, has over 8,000 employees.
Dr. DRYDEN. Yes.
Mr. VON FREMD. Certainly this new administration or this new agency, if it comes into effect, will employ even more people. Historically insofar as I know, it seems that most of the big scientific breakthroughs come with small projects such as the Manhattan Project. Do you think there is a possibility of this new agency becoming unwieldy because of its size?
Dr. DRYDEN. Mr. von Fremd, it is not contemplated that the existing laboratories which are essentially research laboratories will be greatly increased. The bill is written with the very broad authority to work out cooperative agreements or contracts with or without reimbursement, with all sorts of agencies, governmental, State, and private, and the idea is that substantially all of the expansion will be done by contract with existing groups in industry or in nonprofit organizations
Mr. RAYMOND. Sir, on that point you made about the Equator, are you suggesting that it might be useful for us to try to build a launching platform at the Equator, should we look for the place?
Dr. DRYDEN. This will surely come in the future. It will not be a necessity within the next 5 to 10 years.
Mr. RAYMOND. Is there a point in our proposing such a thing as an international projects perhaps, since we talk about the international use of space?
Dr. DRYDEN. It would be quite useful, since the United States owns very little real estate that is on the Equator.
Mr. VONFREMD. I believe we have already had some difficulty with Mexico in regard to our missile program on our down-range bases. Do you think that the Government should start now negotiating with a Latin American country?
Dr. DRYDEN. I think it is a little bit early. Our immediate needs will certainly be met by the existing launching sites. It may be that there will be some field-type operations, just as our early atomic bombs you recall, we sent out what amounted to a field expedition to occupy a certain position, make a firing and then come home.
Mr. NOVINS. Doctor, what do you consider should be the priority objectives of the new agency.
Dr. DRYDEN. In the first place, let me give a personal opinion that the space research and exploration must be priced in context with other activities. For

myself, the ballistic missile program has the highest priority, perhaps a higher priority.

Now within the space program itself, there are certain very high priority military projects like the reconnaissance satellites. Within the new civil agency the immediate thing is to see that this program of scientific satellites is continued, to see probably by cooperation that we begin work on larger boosters for future space activities, especially those in which you are considering putting man into space.

Mr. NOVINS Doctor, one of the things that sort of catches the imagination of the man on the street is the prospect of sending a man to the moon or a platform to orbit around the moon What kind of a timetable could you guess at?

Dr. DRYDEN. Mr. Novins, there is very little disagreement on the directions in which we are going to move, and a lot of disagreement on timetables and course.

On the 50th anniversary of flight I wrote a little prophesy saying I thought that within 50 years we would have man on the moon. Now 5 years have gone by. I would certainly reduce the 50 years very, very considerably. I don't believe that it is going to be done in 5 years. There are a lot of problems We could put a man on the moon but we couldn't get him back As you know, the Russians are able to put a dog in space. We can put a man in space, but we do not yet know and have not yet demonstrated the means by which we get him back again.

Mr VON FREMD. Dr Dryden, do you think that some of the more enthusiastic supporters of a crash space program are overemphasizing their call for immediate and very heavy action right now to try and have a lunar probe to get a man on the moon, to have spaceships? Do you think they are calling for the expenditure of too much money too soon?

Dr DRYDEN I think it would be far preferable, as I said before, to have assured support over a continuing period than to have a very large amount of money for 1 year and then next year wipe out the whole business, because the money would be wasted that way.

Mr. MADIGAN. What specific shot or action would you need the Equator site for? I don't think you could add that up

Dr. DRYDEN. A Mars probe We now have authorized by the President probes in the neighborhood of the moon. If we want to send a probe in the neighborhood of Mars, we would have to do that, I think, from an equatorial site

Mr. RAYMOND. Sir, do you plan to do any of the major probes of that nature from Camp Cook?

Dr. DRYDEN. I think the present lunar probes will probably be fired from Patrick

Mr. RAYMOND. I gathered from what you said about Cook that Patrick was unsuitable and therefore Cook might be used

Dr. DRYDEN No. Cook is needed if you want a polar orbit We are cooperating in a project to put up a very light inflatable balloon. The one in the program now is 12 feet in diameter. We would like to look to the future for a hundred feet in diameter This is something that could be seen by everyone. You don't have to listen to beeps. You would like to put that up on a polar orbit so that it could be seen all over the world. For that you would go to Camp Cook.

Mr. RAYMOND. Dr. Dryden, you made a prediction about a man in space.

Dr. DRYDEN Yes.

Mr RAYMOND. You also spoke favorably of the commercial use of space.

Dr. DRYDEN. Yes.

Mr. RAYMOND. Would you make a prediction for us about the commercial use of space?

Dr. DRYDEN. Yes. Even these very light balloons, especially if we could get one up 100 feet in diameter, are of very great interest from the point of view of communications, worldwide communications, of using this as kind of a mirror to send up your radio or radar or television and bounce off of this satellite to a point over the horizon from where you are, and as a matter of fact some of our communications companies are interested in looking, in studying this possibility.

The other is weather. You have, perhaps, seen estimates of the economic value of an improvement in weather forecasting. It is really quite startling. I don't remember the numbers, but it is a great many hundreds of millions of dollars, if we could increase the reliability of weather forecasts.

Mr. MADIGAN. Doctor, when the Russians beat us with sputnik there was a lot of alibis to the extent that under the International Geophysical Year the only intention of Vanguard was research, anyway, that we weren't doing it as a military viewpoint.

Do you agree with that viewpoint?

Dr. DRYDEN. Yes.

Mr. MADIGAN. Isn't there a possibility here that you will get wide division between the military and research aspects, if we have it divided now, that Russia will again go ahead and again we will lose the psychological race.

Dr. DRYDEN. I don't think so. We certainly have not had it for 4 years in aeronautics. We have had a research in aeronautics working very closely with the military and civil authorities as well.

Mr. VON FREMD. But you had this problem, though, in the case of the first sputniks and the American rockets, because the Army had claimed that they had the ability to put up the satellite long before the Vanguard could.

Dr. DRYDEN This is old history. I don't know how worthwhile, Mr. von Fremd, it is to rake this over. We made a decision that we would let nothing interfere with our ballistic missile program, that we would start this IGY satellite entirely separate.

Mr. MADIGAN. That is just my——

Dr. DRYDEN. The Russians made the decision that they would put their IGY satellite up with their ballistic missile booster.

Mr. MADIGAN. This is just the point that Charles and I have tried to get at.

Can't you visualize the same conflicts 5 or 10 years from now in relation to a space project, where the military can say, "Well, if that darned research outfit over there down the street weren't fooling around, we could have done this a long time ago"?

Dr. DRYDEN. No, because the booster that this new space agency will use certainly for a good many years will come from the military. The only thing we have to put anything in space are Jupiters, Thors. In a little while it will be Atlas and Titan.

Mr. RAYMOND. Dr. Dryden, that seems to confirm the fears of many that you are simply adding another bureaucratic agency to the existing setup.

Dr. DRYDEN. No, it is another agency which, in cooperation with the military, I visualize myself that the firing of Thors will be done by the same people firing Thors now, that the new agency will be concerned with the things which go in the front end of it very largely.

Mr. RAYMOND. But, Dr. Dryden, you described it, and it is described officially as an advisory committee.

Dr. DRYDEN. No.

Mr. RAYMOND. And there are people in Congress who complain that it won't have any jurisdiction at all.

Dr. DRYDEN. Well, the Advisory Committee of the new Agency is not in control of the program. As a matter of fact, this Director does not have to follow their advice at all. It does give a mechanism for getting the views of a broader group of people who come from many branches of science.

Mr. MADIGAN. But the average American, Doctor, thinks in terms of Mr. Holaday, Dr. Killian, now Dr. Dryden. They say, "What goes on here—4, 5, 6 agencies? They were calling for unification and now they are starting a new one."

Don't you think it would be better if you had one overall agency handling both the civilian and military aspects of it?

Dr. DRYDEN. I don't believe that this will meet all of the needs. It is, of course, possible to combine in one agency. There are only 2, however, not 4. ARPA will handle all space problems within the military, and the new agency would handle the——

Mr. MADIGAN. You say it won't meet all the needs. Are you implying there are some faults, then, in this legislation as the President has proposed it?

Dr. DRYDEN. No. I am saying if you combine all of it under the military, there is a fear that the space science part of it would not be carried through, and that some of these civil uses would not be carried through.

Mr. MADIGAN. Are you saying that the field, the scientific community of which you are a member, is fearful, as Jack Raymond started to say in the very beginning, to let the military have any control in this?

Dr. DRYDEN. Not any control, but——

Mr. MADIGAN. You want to limit them, though?

Dr. DRYDEN. Not have overall control; yes.

Mr. RAYMOND. Dr. Dryden, how would you divide between the military and the civilian in this?

Dr. DRYDEN. This is very simple. We are engaged in discussions with ARPA at the present time to see which of the programs the President has approved will be transferred to the new agency. There is complete agreement that the space science programs in their entirety will be transferred. There is agreement that

reconnaissance satellites will remain in the military and certain other aspects of it, and that there will be joint projects in other areas. Man in space, I think, will be a joint project.

Mr. RAYMOND. But we were talking about pure science a minute ago.

Dr. DRYDEN. Yes.

Mr RAYMOND. These powerful rocket engines that must be devised for space vehicles are applicable both to civilian and in the military.

Dr. DRYDEN. The civilian agency will either buy or be given these boosters by the military In fact, I think if I told you that the civil agency would use the Douglas Aircraft Co. crew to fire the Thors for the space science measurement.

Mr. VON FREMD. That brings up another very important point, I believe, Dr. Dryden, and that is that most of the members of the House Space Committee and the witnesses testifying before it have been concerned over the fact that our initial thrust in our rockets is nowhere near that of the Russians.

Do you believe that we should have, well, possibly not a crash program but a very intensive program to get a rocket that can put up, let's say, a four or five thousand pound payload?

Dr. DRYDEN We want a million pound rocket.

Mr VON FREMD. You want a million pound rocket?

Dr DRYDEN. Most certainly this must be started now if you are going to have it in 5 or 6 years.

Mr. RAYMOND. Dr. Dryden, hasn't it been started?

Dr DRYDEN. No. There have been studies made but there is no active development

Mr RAYMOND. What has been holding you back?

Dr. DRYDEN. The assignment of funds to do it and the choosing of this over other projects.

Mr RAYMOND. By whom?

Dr. DRYDEN. At present the responsibility lies within the Department of Defense

Mr. MADIGAN. Is Russia ahead of us in the space race?

Dr. DRYDEN. They have bigger boosters.

Mr. MADIGAN. Are they ahead of us?

Dr. DRYDEN. Yes.

Mr. MADIGAN. On whom do you place the blame, the Defense Department?

Dr. DRYDEN On all of us, the whole country, ourselves. We did not take this matter seriously. Before sputnik if you mentioned the word "space" your appropriations would be cut for wasting the peoples' money on foolish things.

Mr. MADIGAN. Now it is no longer foolish?

Dr. DRYDEN. This is no longer true, although I must point out that the money has not yet been appropriated.

Mr RAYMOND. Dr. Dryden, you made a speech on the coast yesterday in which you expressed fears that people might forget about our space needs and go back to automobiles and color TV and all those things.

Dr. DRYDEN. I think this is a very real fear.

Mr. RAYMOND. Suppose we pose another choice, the choice between a huge bill for space development and school construction.

Dr. DRYDEN. Well, this is the choice that confronts the country and the people's elected representatives are going to have to make that kind of a decision. The rate at which this goes forward will be determined by what decisions are made. Now we know the Russians have made their decision. They haven't stopped since after the war, have been pushing right straight ahead.

Mr. VON FREMD. You say you believe Russia is ahead of us now. How long will it take us to catch up?

Dr. DRYDEN. A few years. I don't know how to specify it any closer than that.

Mr NOVINS. Doctor, I am sorry we won't have a chance to follow that up with you a little more. We would like to very much, but our time has run out.

Many thanks indeed for coming here to Face the Nation, and thanks also to today's panel of newsmen, Jack Raymond of the New York Times, Charles von Fremd of CBS News, and John Madigan of the Chicago American. This is Stuart Novins. We invite you to join us again next week at this time for another edition of Face the Nation.

Our program originated today in Washington.

(Produced by Ted Ayers; associated in production, Bill Kobin; directed by Bill Linden.)

The CHAIRMAN. By the way, General, what do you think about a commission form of agency?

Dr. DOOLITTLE. I much prefer the form submitted in the bill.

The CHAIRMAN. I have an urgent message from the Speaker, but I want to ask one more question before I must leave.

Of course, there is a provision in this bill showing that this agency is likely to expand in the future. I am in agreement with that. I can project my mind and see that this might be the basis of a centralization or coordination of many research activities on what might be called the civilian side.

There are two things there. One, on your request, with the approval of the Agency. Then the concurrence of the President, approval of the President.

There are two double vetoes there.

Dr. DRYDEN. I would say there is encouragement for the two people concerned to get together. If they cannot, there is the opportunity to take it to the President.

The CHAIRMAN. Of course, we should start out with the President anyway. He has the power anyway.

Dr. DRYDEN. He has the power to order anyway.

The CHAIRMAN. You would have no objection to that particular section of the bill being worded in accordance with our constitutional setup?

Dr. DRYDEN. None whatever.

The CHAIRMAN. Now, there is one other aspect, Doctor. You asked for a waiver of the civil-service requirements on the payment of salaries. I will start out by saying I am an enthusiastic supporter of it. What would be the problem if we were to report it out in this bill?

Dr. DRYDEN. The other agencies will hope that you will do the same for them.

The CHAIRMAN. We could act on this because it is a major part, a most important part of the bill, which is the establishment of a new agency. But I do not think we could go across the board and put in there provisions that would apply to scientists and technicians in other agencies.

Dr. DRYDEN. We have written to the other committee, Mr. Chairman, the Post Office and Civil Service Committee, and offered to appear before them and deal with this proposal.

The CHAIRMAN. Do you not think you had better take that whole question up when you go before that committee, rather than having it included in here with the human dissatisfactions that will result in other agencies?

Dr. DRYDEN. I do not want it to fall by the board because the Agency would be almost inoperative without such a provision.

Mr. KEATING. Mr. Chairman, we probably would have jurisdiction to include them all if you would clear it with the chairman of the Committee on Post Office and Civil Service.

The CHAIRMAN. Of course, that is true. Unless that were done it could result in some serious complications.

Dr. DRYDEN. I would hate to see you drop it from the bill, hoping that an amendment is going to be offered by the other committee because I don't think we would get the consideration of the question quickly then. The Agency would be inoperative without it. We would be in desperate shape.

The CHAIRMAN. What about the scientists and technicians employed in other agencies?

Dr. DRYDEN. Most of them with whom I have discussed this question are glad to see somebody pioneer. They rejoice that the problem has been recognized at all.

The CHAIRMAN. I can understand that.

In other words, if you get it in your Agency; they then will have something to hang on to, but what about the raiding that might take place of other agencies? I use that not sinisterly, but in a descriptive way.

Dr. DRYDEN. The plans for the Agency do not involve large increases in Government personnel. I should say that it would be in the order overall of a thousand people of which 200 would be scientists. So most of this expansion is through the contract procedure.

I am saying that the plans certainly do not contemplate a large expansion of the present research facilities with Government employees. The expansion is going to come through operations under contract which do not involve this particular question of raiding.

The CHAIRMAN. If the committee should keep that provision in, it would be quite an inducement for scientists It could be an inducement for scientists and technicians in other agencies who are getting lower salaries than those in your Agency to try to get into your Agency.

Dr. DRYDEN. Mr. Chairman, there are a number of people in other agencies who have called on me who wish to work in the space field.

The CHAIRMAN. I am not saying that the mere salary is the inducement. But it is a very important factor in the lives of all of us. We just cannot disregard it.

If that should be kept in, will you promise the select committee that you will not permit the raiding of other agencies?

Dr. DRYDEN. Most certainly. We have to work with these other people.

The CHAIRMAN. Will you promise the select committee you will cooperate with the other agencies to try to induce the proper standing committees of the House and Senate to change it if it should require it?

Dr. DRYDEN. I certainly will.

The CHAIRMAN. I see the purpose and, as far as I am concerned, I am agreeable. The only question to my mind is one of relativity.

Dr. DRYDEN. We have been working on this program for NACA a long time before there was any discussion of space, and we have made very little progress internally.

With this we have persuaded the administration that this is a necessity if this Agency is going to operate.

Now, the problem is to persuade the Congress that if the Government is to have capable technical people they have to come somewhere near meeting the outside pay scale.

The CHAIRMAN. I started out enthusiastically in support of the bill, but I heard many witnesses testify as to what might be left for the other agencies to do and my enthusiasm started to wane. I am equally frank in saying that as a result of General Doolittle's testimony I am back on the path of enthusiasm now.

Mr. BROOKS (presiding). Mr. McDonough, of California, is recognized.

Mr. McDONOUGH. I am very happy to see you here, General Doolittle. We have great pride in the fact that you come from California and that you attended high school in my district, at the Manual Arts High School.

Dr. DOOLITTLE. Yes, sir.

Mr. McDONOUGH. We know of your great contribution to the science of aeronautics and your new interest, your encouragement in the development of astronautics.

I notice in your statement, which is characteristic of your great confidence in the United States, on page 4, you state:

> The fact that the Russians may accomplish some specific objectives in their space program first should not in itself be permitted to divert us from our designated objectives.

That, I think, is a policy that we should all adopt because we have an objective. We have a purpose. We should not be diverted from our goal by sensational things and the fact that we will have failures from time to time should not discourage us too much.

In that respect, let me ask you this:

You undoubtedly have perhaps as much knowledge as anyone else, being Chairman of the Advisory Committee on Aeronautics, as to the potential manpower in scientific intelligence in this country at the present time to meet the objectives that we have. Do we have such manpower and, in your opinion, are we moving as fast as we can or should at the present time, in space technology?

Dr. DOOLITTLE. We have the manpower, sir. I believe that a program of coordinating that manpower will enable us to move as fast as we should.

I do not believe that we are doing it now.

Mr. McDONOUGH. Do you believe that this Agency which the bill provides should be the parent body that will develop the basic research and provide the specifications for future development on space technology?

Dr. DOOLITTLE. Yes, sir.

Mr. McDONOUGH. Do you think it should encompass and have authority over, or maintain close cooperation with, such organizations as the National Science Foundation and the Weather Bureau?

Dr. DOOLITTLE. Yes, sir.

Mr. McDONOUGH. I notice that you recommend, and I am inclined to agree, that more than one military representative should be on the Board; that the Agency should be civilian controlled and be devoted to the development of space technology for civilian interests and for peacetime purposes.

Dr. DOOLITTLE. Yes. It will, however, support the military in many ways.

Mr. McDONOUGH. I do not disagree with that a bit.

However, the basic philosophy in this country is the civilian control of military or, at least, have authority over it, and in this instance it should also apply?

Dr. DOOLITTLE. Yes.

Mr. McDONOUGH. You believe that this Agency ought to absorb the NACA and include it in its authority?

Dr. DOOLITTLE. It should absorb the duties of the NACA; the personnel of the NACA, and the facilities of the NACA.

Mr. McDonough. And then expand from there into space technology?

Dr. Doolittle. I do not believe it will be necessary to greatly expand the governmental facility, but it will expand largely through contracting outside the Government.

There will be some increase required in the NASA administrative organization because of the new duties that it will take on.

Mr. McDonough. Do you recognize a great difference between space or astronautics and aeronautics?

Dr. Doolittle. I consider that they form a spectrum and there is a great difference between the two ends of the spectrum, but they grow together in the middle.

Mr. McDonough. You mean that the development of aeronautics at the present time leads into astronautics?

Dr. Doolittle. Yes, sir.

For instance, the NACA is presently spending almost half of its time directly or indirectly on matters that help in astronautics. That has been a direct outgrowth of their work in aeronautics.

Mr. McDonough. Now, as to our industrial capability in this country to produce the materials necessary for security in space and scientific investigation and exploration of space, do you think that we have all the facilities that we need in this country for that purpose?

Dr. Doolittle. I think we will continue to have additional facility requirements, but most of those will be obtained from industry and from research organizations and from the universities.

To answer your question directly, I do not feel there is an immediate requirement for more governmental laboratories.

Mr. McDonough. To what extent should this Agency act in the operating field in the production of hardware and material for experimental purposes?

Dr. Doolittle. I believe they will get much of their hardware from the military initially and that they will contract for that hardware that they do not get from military to industry.

Mr. McDonough. Do you think we should add an incentive in this bill for encouragement of scientific manpower to come to the Government for work in this industry and to aid us?

Dr. Doolittle. I would not quite know how to go about it.

Mr. McDonough. I mean some more attractive salary proposals?

Dr. Doolittle. That is in here.

Mr. McDonough. I mean the average employee, to encourage the young man.

The upper echelon is provided for in the bill. I refer to the average scientist, engineer, meteorologist.

Dr. Doolittle. The greatest incentive is increased pay.

Mr. McDonough. That is right. Do you think that the bill should provide that?

Dr. Doolittle. I do not believe it is necessary to write it out in the bill. I believe the ability to meet pay outside of Government is in the bill, and that is all that is required.

Mr. McDonough. Thank you very much, General Doolittle. I appreciate your appearance here.

Mr. Brooks. Mr. Keating.

Mr. Keating. General Doolittle, you occupy a prominent place in minds and hearts of the people of our country. You occupied such

a place first during your courageous exploits in World War II, and you have been deep in our hearts and minds recently.

The importance of what you say here is indicated by the influence you have had on our chairman.

At the present time as Chairman of the Committee, as I understand it, the Director reports to the President through you?

Dr. DOOLITTLE. Yes, sir; at the present time.

Mr. KEATING. Why do you feel it is desirable to change that to have the Director of the new Agency report directly to the President?

Dr. DOOLITTLE. I do not believe that it makes a great deal of difference whether the Board of the new Agency is advisory board, or executive board.

I believe in the old agency it functioned very well as an executive board. In this new Agency it is desired that the Director should have complete authority in order that he might operate as expeditiously as possible. I imagine that there was a feeling that if the Board remained an executive board there might be some delay entailed and that the Director might not be able to operate as rapidly.

With the Advisory Board there is no possibility of delay.

Mr. KEATING. Has delay been encountered under the existing setup?

Dr. DOOLITTLE. I would rather you ask the Director that question.

Dr. DRYDEN. Under the existing setup a great many powers have been delegated by the present Board. I think there was a feeling of the drafters of the bill that you should not leave that chance.

In other words, the Board is not required to delegate the Director and, therefore, the organization is composed in the way you have it in the bill so there is no possibility there would be this situation where there was delay.

Mr. KEATING. You have a personal preference as to the method of administration, General Doolittle?

Dr. DOOLITTLE. You mean whether it be an executive board or advisory board?

Mr. KEATING. Yes.

Dr. DOOLITTLE. My original opinion was that it should be an executive board because that operated so well. I am satisfied, however, that the importance of getting this legislation through and getting on with the job is far more important than whether the Board should be executive or advisory.

Consequently, I am now very happy with an advisory board.

Mr. KEATING. But you adhere to the view personally that the executive board would be preferable?

Dr. DOOLITTLE. It has been. It has operated very effectively in the past. That is a compromise. I think it is a good compromise, and I am now in favor of it although my original contention was that the executive board was better.

Mr. KEATING. There has been considerable discussion here about a commission as opposed to a board, General Doolittle, a commission of, let us say, five members with a chairman.

You favor this setup?

Dr. DOOLITTLE. I favor this type contained in the bill for several reasons. First, I like the direct clear-cut authority which the Director has.

Secondly, I like to have all the agencies with whom the director is involved periodically at hand so that he can consult with them.

This occurs in this type of board. It will not occur in the five-man commission type.

Mr KEATING. Except by some liaison arrangement?

Dr. DOOLITTLE. The liaison here is automatic.

Mr. KEATING. Under this setup it is automatic?

Dr. DOOLITTLE. Yes. I would say also that with a board of this kind, none of whom draw any pay, all of whom are interested in the work, that the Government is able to get very useful people working for it for nothing.

Mr. KEATING. That is certainly true in the NACA, not the least of whom is our present witness.

The bill as proposed says that the Chairman shall come from the public members only. There has been some discussion on that. Do you think that limitation should be in the bill, or should it be possible to appoint the Chairman from the people in Government?

Dr. DOOLITTLE. Personally I do not feel that it would make any great difference if a governmental member were appointed Chairman, but there would be the feeling certainly that it was possible for the Chairman, if he came from Government, to speak for his agency and this is obviated by having him not come from the governmental 8, but from the civilian 9.

Mr. KEATING. There has been a suggestion made that there is a danger in selecting public members, of having a conflict of interest and particularly if the Chairman were from the public members, that such conflict of interest might be greater than his conflict of interest if he were from Government. Do you have any comment on that?

Dr. DOOLITTLE. First, I would like to say that great value has come from the industry members. They have brought a great deal of knowledge and help to the Board and to the Director.

Secondly, I would say in the past it has been customary to select a chairman from other than industry members.

For instance, to go down the list of Chairmen, first was General Scriven and Dr. Durand, Dr. Freeman, Dr. Walcott, Dr. Ames, Dr. Bush, Dr. Hunsaker, and now myself.

They have always been selected from other than strictly industry members and have thus obviated the possibility to which you refer.

I still do not feel it is a hazard, however.

Mr. KEATING. If the arrangement is made as suggested here, the Director reports as the head of this Agency to the President, and I appreciate your comments with reference to the present creation of a Department of Science, in which I concur at present.

I think personally such a time will come, but I do not think it is here yet.

If this Director reports to the President, is this not of sufficient importance that he should participate in the formulation of policy at the very highest level by attending Cabinet meetings and sitting with the National Security Council?

Dr. DOOLITTLE. As long as the President has a science adviser, Dr. Killian, who sits at these high-level meetings, I do not think it is necessary that the Director of the NASA sit there.

Mr. KEATING. What would be the relationship if the President's scientific adviser continued in office, if this were not a temporary

arrangement and he continued there? What would be his relationship to the Director of this Agency?

Dr. DOOLITTLE. That would be entirely determined by the authority that the President chose to give to his science adviser.

Mr. KEATING. You do not think it would be appropriate in this legislation for us to deal with that question?

Dr. DOOLITTLE. No, sir.

Mr. KEATING. I agree.

Regarding the liaison with the military, there has been a suggestion made that we should spell out in the bill itself the terms of that liaison. Do you agree with that, or do you take the position that we should simply perhaps put in a pious declaration to the effect that liaison should take place?

Dr. DOOLITTLE. Some liaison presently takes place at the level of the executive board. The liaison will continue to take place at the level of the advisory board.

Liaison also takes place before main committees and in various subcommittees. It might even be desirable at some later date to have a decision committee that would be made up of Dr. Killian, a senior member from the Department of Defense, the director of the NASA, Chairman of the AEC, and the Director of the National Science Foundation, to decide just exactly how the jobs would be allocated because they are the five primary agencies involved.

Now, that requires no legislation. If that becomes necessary, the President can appoint such a committee to do that job.

I do not feel that legislation is required.

Mr. KEATING. Would you repeat, please, the personnel of this proposed decision committee as you suggested?

Dr. DOOLITTLE. I would envisage a decision committee where there was any lack of report between the agencies primarily involved in the space program and that would be Dr. Killian, who is the President's science adviser; it would be a senior member from the Department of Defense, probably the Deputy Secretary of Defense, Mr. Quarles; the director of the NASA, who we presume will be Dr. Dryden—I certainly feel that he is the man in the United States most capable to do that job—the Chairman of the Atomic Energy Commission, Admiral Straus, and the Director of the National Science Foundation, Alan Waterman. They are the individuals who are, in my mind, primarily involved. They are all at the decision level.

Then, for instance, this gray area of which we spoke—any point on what should go to the NASA, what should go to the military, what should go to the National Science Foundation—then those problems can be resolved by that high-level committee.

But again no legislation is required, the President could appoint such a committee.

Mr. KEATING. You feel they are the best qualified men to reach such a decision?

Dr. DOOLITTLE. Yes, sir.

Mr. KEATING. I think that is very significant, General Doolittle. I think that is a very helpful suggestion, although I would agree that it would be inappropriate for us to embody anything of that kind in this legislation.

Now, liaison particularly with the military, you would agree, would have to take place at all levels at present?

Dr. DOOLITTLE. It does presently.

Mr. KEATING. The Atomic Energy Act sets up, in rather precise form, the manner by which that liaison should be accomplished.

Do you think we have reached the point in this Agency where we should endeavor to do that in this legislation, or should we wait until things have been at work for a while?

Dr. DOOLITTLE. I do not think anything is required in legislative form at this time.

Mr. KEATING. It would be better to wait and see what is needed in the form of such a liaison committee?

Dr. DOOLITTLE. Yes, sir.

Mr. KEATING. It has been asserted that this committee simply could be spinning its wheels here since authority exists for nearly all space projects either in the military or in NACA or in other agencies.

I do not share that view. I think the creation of this Agency is of extreme importance but that has been asserted here by several.

Would you comment on that, General?

Dr. DOOLITTLE. I believe it is a very useful committee, sir.

Mr. KEATING. Do you think that the Agency is useful or is it essential?

Dr. DOOLITTLE. It is a very useful concept. I feel the Agency will do an outstanding job.

Mr. KEATING. Will the Agency do a better job than these separate departments or elements of Government would do on their own without an Agency?

Dr. DOOLITTLE. They will do a better job and do it more quickly and do it more cheaply.

Mr. KEATING. How important do you think it is that we take a shot at the moon within this year?

Dr. DOOLITTLE. I would, rather than say arbitrarily that we take a shot at the moon, say that we would establish a comprehensive program, that program will go ahead for the purpose of achieving instrumented flight in space as quickly as possible.

I would say that a quick shot at the moon, as a stunt, would not be of great value, and it would be of great value only if it fitted in as an integral part of this comprehensive program.

As a matter of fact, at the present time there are substantial reasons why we should not take a shot at the moon. The moon happens to be, we presume, a very clean place. The scientific fraternity is very anxious to keep it so, without contamination, until by instrumentation or manned exploration we can find out more about it.

Mr. KEATING. You do not think that the rumored Russian shot at the moon, so called, should deter us from our program in any way?

Dr. DOOLITTLE. That is one of the things that I would say should not deter us from a well-thought-out program.

Dr. DRYDEN. Mr. Keating, may I say there are, as you know, three lunar probe shots authorized. I think that what is expected there is to get in the vicinity of the moon, to test out certain ideas on guidance and certain scientific equipment that may be included in the front end. These are programs that have already been authorized in this interim period.

Mr. KEATING. Is it intended to take pictures of the moon?

Dr. DRYDEN. This is one proposal. I am not familiar with the exact contents of the program.

Mr. KEATING. Does the lunar probe involve equipping with cameras or television equipment the vehicle which we send up?

Dr. DRYDEN. I do not know whether I would use exactly that word. Certainly in the early shot, because of the relatively small payload, it will be primitive form of camera and television system.

Mr. KEATING. General, I was very much interested in your statement, with which I heartily concur, that we must arrive at an international agreement for the peaceful uses of outer space.

Do you not agree that we must preliminarily reach such an agreement as to how high the sovereignty you might say of each nation is to extend? That is the first thing to agree upon, is it not?

Dr. DOOLITTLE. Yes, sir.

Mr. KEATING. Do you not think it would be helpful for this country to take the lead in encouraging such an international conference for that purpose?

Dr. DOOLITTLE. I do.

Mr. KEATING. Would you think it better to suggest that the United States do this separately or to suggest that it be done through the United Nations?

Dr. DOOLITTLE. It would seem to me that through the United Nations would certainly be the proper place to start because all nations are involved in space whether they are in it yet, or not.

Mr. KEATING. Of course, all nations are not in the United Nations.

Mr. DOOLITTLE. It certainly is an excellent forum with which to start.

Mr. KEATING. You share my view that the United States should absolutely and with reasonable dispatch make such a suggestion to other nations?

Dr. DOOLITTLE. Yes, sir.

Mr. KEATING. Just finally, we had a little talk about the name of this agency and I share your view it does not make much difference what the name is, but of course, in fixing on a name in this city we have to find a combination of initials that will sound good.

Now, NACA becomes NASA. If we had this one that Congressman Fulton suggested, it would be the NAAA. Now, that would not be very good. I should think the importance of this is pretty much just about that important, to get some initials that will stick in peoples' minds. Beyond that the name makes very little difference.

Dr. DOOLITTLE. I am pleased to have the word "advisory" out because it is a misnomer. I do not believe that the name should actually say something that is not so.

On the other hand, it should say as much as possible what the agency actually does.

Mr. KEATING. There are quite a few ideas that come to mind, but I guess I had better defer those.

Dr. DOOLITTLE. I believe the aeronautics should be in there because we are going to continue the aeronautical field.

Mr. KEATING. You think it is important to have the word "aeronautics" in there?

Dr. DOOLITTLE. Yes, sir.

Mr. BROOKS. Mr. Ford.

Mr. FORD. I have no questions.

Mr. BROOKS. Mr. Feldman.

Mr. FELDMAN. General, I believe you stated earlier that the first function of the new agency NASA was to spell out a program.

Dr. DOOLITTLE. Yes, sir.

Mr. FELDMAN. Has such a program been spelled out?

Dr. DOOLITTLE. Dr. Dryden is working on that. I would like to have him tell you what he has done.

Dr. DRYDEN. There is a plan under formulation in the final stages. It will be submitted very shortly to the Bureau of the Budget.

I think until some action is taken there I would rather not bring it into the committee. I can tell you the general nature of it.

Mr. FELDMAN. Can you give the summary of the program?

Dr. DRYDEN. Would you like me to put it in the record, Mr. Feldman?

Mr. FELDMAN. I do not mean at the moment.

Dr. DRYDEN. We can put that in the record, without money attached to it, just the subjects which are included in the program we are discussing.

Mr. FELDMAN. That will be satisfactory.

(The material referred to follows:)

PROPOSED PROGRAM OF NATIONAL AERONAUTICS AND SPACE AGENCY

I. Unmanned space flights to acquire scientific data:
- A. Vertical probes.
- B. Satellites to study space environment.
- C. Lunar probes.
- D. Planetary and interplanetary probes.
- E. Weather reconnaissance.
- F. Communications developments.
- G. Astronomical observations.

II. Investigations of manned space flight:
- A. Small-scale recoverable orbiter.
- B. Vertical flight and reentry vehicles.
- C. Manned orbital and reentry vehicles.
- D. Supporting biological studies.

III. Research and development on advanced components and techniques:
- A. Propulsion systems:
  1. Development of special rocket motors using conventional propellents.
  2. Development of high-energy rocket motors.
  3. Initial contract development of million-pound thrust rocket motor.
- B. Vehicular subsystems:
  1. Auxiliary power supplies.
  2. Controls.
  3. Communications.
  4. Displays.
  5. Personnel equipment.
  6. Guidance systems.
  7. Computers.
- C. Instrumentation.
  1. Vehicle-borne scientific instruments.
  2 Tracking systems.
  3 Telemetering systems.
- D. Vehicles
  1 Stabilized satellite space platform.
  2. Propulsion and subsystems test vehicles.

IV. Research facility requirements
- A. Adaptation of pilotless aircraft research station for handling large liquid-fuel rocket motors.
- B Extension of instrumentation facilities.
- C. High-energy rocket research facilities.
- D. Guidance and control facilities.

V. Personnel and operating expenses:
- A. Administration.
- B. Research and supporting staff.
- C. Travel.

Mr. Feldman. Earlier in your testimony, General, you spoke of the fact, if I understood you correctly, that there is at present pending legislation to increase the present NACA board from 17 to 19 members and to add to that board members from the Department of the Army which would make it 6 from the military in all. Is that not so?

Dr. Doolittle. The present membership of the board is 17. The Army originally had representation, 2 from the Army and 2 from the Navy.

In 1947, when the unification bill was passed, the Air Force came on and took over the two Army places. Since that time the Army has not had representation on the main board.

As they have gotten into the air and space age, it seems that they should have representation. So we have requested legislation giving representation to the Army. That would give them 2 places also and then the board will have been increased from 17 members to 19 members.

Mr. Feldman. You are satisfied with the present operation of NACA, is that not so?

Dr. Doolittle. I am very proud of the present operations of it.

Mr. Feldman. And the board functions as the executive authority of the agency?

Dr. Doolittle. It has operated very well.

Mr. Keating. Would the gentleman yield at that point, please? General Doolittle, one thing I neglected to ask you is this:

There was some discussion here of the Presidential directive to the Defense Department and to your agency for addition of powers. Are you at liberty now to release the text of that directive so that it may be incorporated in the minutes?

Dr. Doolittle. It is my understanding we are. I have a copy of memorandum for the Secretary of Defense, Chairman, the National Advisory Committee for Aeronautics, dated April 2, which I will be very pleased to leave with the committee.

Mr. Keating. I suggest, Mr. Chairman, that be made a part of the record.

Mr. Brooks. It will be placed in the record.

(The material referred to follows:)

The White House,
Washington, April 2, 1958.

Memorandum for: The Secretary of Defense Chairman, the National Advisory Committee for Aeronautics.

I have today transmitted to the Congress a special message recommending the establishment of a National Aeronautics and Space Agency. A draft of legislation carrying out this proposal is being transmitted to the Congress by the Director of the Bureau of the Budget.

The new Agency will be based on the present National Advisory Committee for Aeronautics and will continue that agency's well-established programs of aeronautical research. In addition, the new Agency will be responsible for programs concerned with problems of civil space flight, space science, and space technology. The instructions outlined below are concerned with these new activities.

The ultimate potentialities of space flight cannot now be fully grasped. Since some of these potentialities are clearly of significance from the standpoint of our national security, the Department of Defense will have a continuing interest in the programs to be undertaken and will continue to sponsor programs which may

be peculiar to or primarily associated with military weapons systems or military operations as well as certain research and development which may be of a general supporting character Furthermore, I desire that the skills and experience that have been developed within the Department of Defense be fully utilized in support of civil space programs. However, it is appropriate that a civilian agency of the Government take the lead in those activities related to space which extend beyond the responsibilities customarily considered to be those of a military organization

I consider it especially felicitous that the National Advisory Committee for Aeronautics will provide the basic organization on which the new Agency will build. Not only does the National Advisory Committee for Aeronautics itself already have a firm understanding of the key problem areas involved and a tested method of approaching such problems, but also this organization and the Department of Defense have long enjoyed a highly productive working relationship. This relationship will ease the period of transition that lies ahead and will provide a basis for the close cooperation that will be needed to solve the difficult problems that will be encountered. It is intended that the new Agency continue to perform for the Department services in support of military aeronautics and missiles programs of the type now performed by the National Advisory Committee for Aeronautics and also provide similar services with respect to military space programs; the Department, in turn, will provide support essential to the success of the new Agency.

In order that necessary work proceed without loss of momentum pending enactment of the proposed legislation, in order that interim measures may be consistent with the intent of this legislation, and in order that implementation of the legislation, when enacted, may be promptly initiated, I desire that the Department of Defense and the National Advisory Committee for Aeronautics take the following actions:

1. The National Advisory Committee for Aeronautics should prepare and present to the appropriate committees of the Congress a full explanation of the proposed legislation and its objectives

2. The National Advisory Committee for Aeronautics should proceed to formulate such detailed plans as may be required to reorient its present programs, internal organizations, and management structure to carry out the functions to be assigned to the National Aeronautics and Space Agency, including the functions now being performed by the National Advisory Committee for Aeronautics, and should also plan and propose such additional actions and programs as may be necessary to implement the proposed legislation. Such actions would include determination of any requirements for additional staff, facilities, or funds that may be needed in the immediate future.

3. The Department of Defense and the National Advisory Committee for Aeronautics should jointly review the pertinent programs currently under way within or planned by the Department, including those authorized by me on March 27, 1958, and should recommend to me as soon as possible which of these programs should be placed under the direction of the new Agency. The Department of Defense and the National Advisory Committee for Aeronautics should also prepare an operating plan to assure adequate arrangements for utilizing in support of the new Agency, either by cooperative arrangements or by transfer to the new Agency, appropriate organizations, facilities, and other functions now within the Department. These actions should be taken in the light of the fact that the proposed legislation contemplates that the new Agency will be given responsibility for all programs except those peculiar to or primarily associated with military weapons systems or military operations.

Supporting research and development should be coordinated to provide for the needs of both military and civil programs without unnecessary duplication. It should be noted that Public Law 85–325 authorized the Department of Defense for a period of 1 year to engage in advanced space projects designated by me. The 1-year period will come to a close February 12, 1959. Since the new Agency will absorb the going organization of the National Advisory Committee for Aeronautics, it should be capable of assuming direction of appropriate programs prior to that date.

4. The National Advisory Committee for Aeronautics should discuss with the National Science Foundation and the National Academy of Sciences, as well as other governmental and nongovernmental bodies, the matter of participation of the scientific community on a continuing basis in planning and coordinating the scientific programs for the use of space vehicles in civilian space science. The best scientific judgment available in determing space science objectives should be

utilized. Matters related to dissemination of the data collected should also be considered.

5. The Department of Defense should identify and report to me what programs now appear to be needed in support of well-defined military requirements. It is understood that the Advanced Research Projects Agency will continue to serve as the focal point for such programs within the Department.

Any problems that may arise in carrying out these interim instructions should be discussed with my Special Assistant for Science and Technology or with the Bureau of the Budget, as appropriate.

DWIGHT D. EISENHOWER.

Mr. BROOKS. May I interrupt counsel for the moment?

In withdrawing the two representatives of the Army from the Board, was that done as a corollary or at the same time that the mission of the Army in aeronautical work was limited to short-range missiles?

Dr. DOOLITTLE. No, sir; this was done in 1947 when the unification bill became law.

Mr. BROOKS. Why was the Army withdrawn from that?

Dr. DOOLITTLE. Because the Air Force at that time was given the air mission.

Mr. BROOKS. And the Army had no air mission at all at that time?

Dr. DOOLITTLE. That is correct, except I believe, liaison.

Dr. DRYDEN. They were never on the committee.

Mr. BROOKS. I know when the Air Force was made a separate entity, it had representation and it took over the Army unit.

Dr. DRYDEN. That is right.

Mr. BROOKS. That is all, Mr. Feldman.

Mr. FELDMAN. Yesterday, Admiral Raborn told us about the Polaris project. He pointed out the striking similarity between that project and the old Manhattan project. He is doing this unusual job which could be in many ways likened, and which he likened, to the spaceship job that an agency of the Government could undertake, and he is doing this under a directive from the Secretary of the Navy.

There was no special legislation necessary to accomplish this purpose. Other than the several relatively minor provisions in the new proposal, is it not possible for for the NACA to undertake that kind of function under its present legislative authority?

Dr. DOOLITTLE. To develop a project like Polaris?

Mr. FELDMAN. That is right.

Dr. DOOLITTLE. Well, the first requirement would be to have money. Then you have to have the authority. We lack the authority and the money to do it.

Mr. FELDMAN. Assuming you could to to the budget and have the Budget Bureau approve such a project, money for such a project, would legislation then be necessary?

Dr. DOOLITTLE. The subject is really academic because if we went to the budget and asked for authority to ask for money to start a development such as Polaris, we would be thrown out.

Dr. DRYDEN. We don't have the authority to buy an airplane, much less develop one.

Mr. FELDMAN. So that it takes this special legislation and a new charter to give the new Agency that authority?

Dr. DOOLITTLE. That is right.

Mr. FELDMAN. Now what is your understanding of the functions of liaison between an agency? Isn't it something that should be continuous and constant?

Dr. DOOLITTLE. The relationship between what?

Mr. FELDMAN. Your understanding of the word "liaison"; isn't it something that should be continuous and constant?

Dr. DOOLITTLE. My understanding of the word "liaison" is that it is a working relationship between two agencies.

Mr. FELDMAN. And it usually is continuous; is that not so?

Dr. DOOLITTLE. It need not be continuous, but it must be available when required.

Mr. FELDMAN. Is it not usually required when there is a continuous relationship between two agencies?

Dr. DOOLITTLE. I do not understand the question.

Mr. FELDMAN. For example, the military here would be tied up pretty closely with the new Agency?

Dr. DOOLITTLE. Yes.

Mr. FELDMAN. And they will require almost continuous reporting on what is going on in NASA, the new Agency that will be set up?

Dr. DOOLITTLE. We have military people in our laboratories so that there is continuously liaison at the present time.

Mr. FELDMAN. Is that by law?

Dr. DRYDEN. No, not by law.

Mr. FELDMAN. Would there be any harm in amending the law so that it would require it?

Dr. DRYDEN. As I testified before, I certainly have no objection if the committee wishes to do that.

Mr. FELDMAN. What percentage of the principal NACA work is military in character?

Dr. DOOLITTLE. A large percentage.

Dr. DRYDEN. It is a matter of definition. About 15 percent is on specific military projects, on airplanes, missiles, engines, by name.

Now you have a broad program of applied research which can be used on military airplanes or civilian airplanes. A great part of it is motivated by the problems which are only at the present moment encountered by military airplanes.

In other words, no civil aircraft is now flying at Mach 3, for example.

We have extensive applied research programs on aircraft at Mach 3. So you can state this narrowly as 15 percent on specifically military project support, or on behalf of the military.

The other extreme is 15 percent which is future, pure science, if you like.

In between you have 70 percent of applied research which you can interpret as applicable to both, perhaps half or three-quarters of it is motivated by the problems which at present come only in military aircraft and missiles.

Mr. FELDMAN. I do not think the answer is too responsive, but I suppose it cannot be.

Dr. DRYDEN. What is your definition of military? What is military research? You do research on a problem of a wing section for an airplane. You can use that wing section on a military airplane or civilian airplane.

Mr. FELDMAN. Where do most of these requests come from, Doctor?

Dr. DRYDEN. The requests for specific work originate in the military. Most of the program for applied research comes through the military, civilian staff members of our subcommittees and from the laboratories themselves.

We have an independent responsibility at present to guess what is coming, to try to see that the information is available when the military needs it.

Mr. Brooks. May I interrupt there for just a moment. The second bell has rung on the floor. We are going to have to go.

I was wondering how many more question you have, Mr. Feldman?

Mr. Feldman. I do have a number of questions. I dislike having the gentleman remain over because I know he has something pressing this afternoon.

Mr. Brooks. We have no alternative ourselves.

Is it possible to submit the questions to the general to answer them?

Dr. Doolittle. I would be pleased to stay and answer the questions directly.

Mr. Brooks. Counsel asks permission to file these questions in the record and the general has agreed to answer those questions in response to the request. If there is no objection, that can be done.

Now I would suggest also that if Mr. Feldman wants to communicate directly with you and will tell you just exactly what information he wishes in the record in response to the question, it might help.

We will not be able to maintain a quorum. I know everybody wants to vote and we have no alternative.

General, on behalf of the committee, it has been delightful to have you here and you have really helped the committee a great deal with your most valuable testimony.

I think it will have a far-reaching effect upon the people of the country. We also want to thank the other gentlemen, Dr. Dryden, and Mr. Dembling, for their assistance. The committee will adjourn until 2:30, and at that time we have Dr. Joseph Kaplan and Dr. Allan T. Waterman, who will be witnesses.

The committee is recessed until 2:30.

(The questions and answers referred to follow:)

Replies of Dr. James H. Doolittle, Chairman, NACA, to Written Questions of George S. Feldman, Director and General Counsel, Select Committee on Astronautics and Space Exploration, United States House of Representatives, May 5, 1958

Question 1. In your opinion, should research into the problems of space flight be under civilian or military control? For what reasons?

Answer. Research into all but the strictly military aspects of space flight should be under civilian control. Control should be in the area of principal interest. Only there will it get adequate support.

Question 2. The President's bill provides (sec. 2) for exclusively civilian control "except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations * * *" (p 2, lines 7–9).

(*a*) Approximately what proportion of the activities of the outer-space agency do you anticipate would come within that exception? A substantial part? Only a small part?

(*b*) What would your answer have been if the exception read:"* * * pertaining to weapons systems or military operations"?

Answer. (*a*) A relatively small part. (*b*) A larger part.

Question 3. Assuming, for example, that the outer-space agency could take over the Vanguard and Redstone projects, under its contract and lease authroity (p. 8, subsec. 6 (5)) or its transfer authority (p. 15, sec. 8), should it do so, in your opinion, or should those projects remain under military control?

Answer. It might take over Vanguard but not the missile part of Redstone. These points are under discussion now and will be decided in conference between agents of the DOD and the NASA.

Question 4. In your opinion, to take a further example, what agency should have charge of developing a 1-million-pound-thrust rocket? The outer-space agency? ARPA? AEC?

(According to testimony by Secretary McElroy on February 26, 1958, before the Senate Preparedness Investigating Subcommittee, the Air Force has charge of this project.)

Answer At present there is no obvious military requirement for a 1-million-pound-thrust rocket. There is a civilian requirement. It should therefore, be developed by NASA. If it is to be nuclear powered, this should be done in collaboration with the AEC.

Question 5 The President's bill contains authority to operate as well as to develop and test aeronautical and space vehicles (see p. 6, lines 1 and 2; p. 7, lines 7 and 8).

(*a*) In your opinion, does the outer-space agency need such authority?

(*b*) Does the NACA have authority to operate aeronautical vehicles?

Answer. (*a*) Yes. (*b*) At present the NACA operates aeronautical vehicles in connection with their research programs.

Question 6. In the light of your experience with the NACA, would you favor a policymaking committee for the outer-space agency or merely an advisory board such as the President's bill provides (secs. 4 and 5)?

Answer. The policymaking committee concept has worked very well for the NACA. The committee has been able to both help and protect the Director. I personally like the concept but think it much more important to get on with the enactment of the legislation requested by the President than to quibble about this point.

Question 7. The President's bill provides (subsec. 6 (b) (2) for rates of pay "which are reasonably comparable with prevailing rates paid by non-Federal employers for similar work" (p. 7, lines 1 and 2).

(*a*) In your opinion, is this provision necessary? For what reasons?

(*b*) It has been suggested that an authorization for a substantial number (perhaps 200 or 300) scientific and professional positions at $12,500 to $19,000 would be adequate. Do you agree? (The NACA now has a small number (30?) of such positions)

Answer (*a*) Yes This provision is necessary so that the pay scales for NASA Government and contract operated laboratories will be on the same basis. (*b*) No. It should apply to all hard to obtain and retain personnel.

Question 8. The Atomic Energy Act contains: (*a*) rather detailed provisions (ch. 11, secs 121–125) for international arrangements and cooperations; and (*b*) provisions for indemnification up to an aggregate amount of $500 million and for limitation of liability (sec 170).

In your opinion, should the President's bill be amended so as to include similar provisions?

Answer. (*a*) Dr. Dryden, in response to your committee's request, has prepared a draft covering this question. With this I agree. (*b*) I have no objections to inserting such provisions.

(Thereupon, at 12:25 p. m. the committee recessed until 2:30 p. m., same day).

AFTERNOON SESSION

The CHAIRMAN. The committee will be in order.

We are very glad to have with us, as the next witness, Dr. Alan T. Waterman, Director of the National Science Foundation. You may proceed, Doctor.

STATEMENT OF DR. ALAN T. WATERMAN,[27] DIRECTOR, NATIONAL SCIENCE FOUNDATION, ACCOMPANIED BY JAMES M. MITCHELL, ASSOCIATE DIRECTOR, AND WILLIAM HOFF, GENERAL COUNSEL

Dr. WATERMAN. Mr. Chairman and members of the committee, I am very happy to appear before you today to give my views on matters relating to the need for efforts to accelerate our progress in space research, technology and exploration, and more particularly regarding proposed organizational arrangements within the Government for this purpose.

At the outset let me state that I heartily endorse the general outline of H. R. 11881, H. R. 11882 and S. 3609, which I believe are before you.

The establishment of a new civilian agency appears to me to be the best method for carrying out the objectives desired. This is particularly true since the new agency could retain the successful experience and excellent relationships of NACA.

In addition, in my opinion, the importance of this subject is such as to justify its assignment to a particular agency with the specific purpose assigned to it here.

In this way the hard-won lessons of the past will assist us to make the most rapid possible progress in developing the means for exploration and of actual flight in outer space.

Furthermore, the vast new horizons that will be opened up by progress in this area of sceintific activity are of concern to very many segments of the national community; they include, but stretch far beyond purely military considerations.

Finally, a civilian-led program would place this country in a position to cooperate with other nations with respect to conquering the problems of space exploration, and would better assure a cooperative world reaction than would an effort conducted by the military.

The impetus for a determined effort is the direction of space exploration was, as you know, provided by the International Geophysical Year.

The Comite Special de l'Anne le Geophysique Internationale passed a resolution in 1954 encouraging any nation if possible to put a satellite in orbit during the International Geophysical Year.

As you know, this challenge was accepted by the United States and later by the U. S. S. R.; as a result both countries have succeeded in placing satellites with different characteristics in various orbits.

As the world appears clearly to recognize, we stand on the threshold of a truly impressive phase of exploration. For the first time man is

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[27] Waterman, Alan Tower, physicist, born Cornwall-on-Hudson, New York, June 4, 1892; son Frank Alan and Florence (Tower) W , A B , Princeton, 1913, A. M , 1914, Ph D , 1916, D. Sc , 1952, Sc. D. (hon), Tufts Coll., 1952, Northeastern U., 1953, m. Mary Mallon, Aug 1917; children—Alan Tower, Neil John, Barbara (Mrs. Joseph R. Carney), Anne (Mrs William C Cooley), Guy van Vorst. Instr. U. Cincinnati, 1916-17; Instructor physics, Yale, 1919-22, assistant professor of physics, 1923-30, National Research fellow, physics, King's Coll., London, 1927-28, asso prof. of physics Yale University, 1931-48, dep chief and chief scientist Office Naval Research, Navy Department, 1946-51; dir. Nat Sci. Found., 1951- Dir. Center for Advanced Study in Behavioral Sciences Served from private to first lt., Science and Research div. Signal Corps, U S Army, 1917-19, served as vice chmn div D, Nat. Research Defense Com , 1942-43; dep. chief office of field service, OSRD, 1943-45, chief, 1945. Chief reader, physics, coll. entrance examination board, 1935-41, chief examiner, physics, 1937-49. Fellow A A A. S., Am Phys. Soc , Am. Assn Physics Teachers; mem Am. Inst E. E , Washington Acad Sci , Philos. Soc, Wash , R. E S A , Am. Assn U. Profs , Scientific Research Soc. Am. (governing bd); Phi Beta Kappa, Sigma Xi, Clubs· Graduates, (New Haven), Cosmos (Wash.). Medal for Merit, 1948 Editor· Combat Scientists, 1947 Mem. editorial bd., Am. Jour. of Sci., 1934-42 Contbr sci. papers to The Phys. Rev , Am. Jour. of Sci , Philos. Mag , Proc. Royal Soc. Home 5306 Carvel Rd , Westmoreland Hills, Washington 16. Office: Nat. Science Found., Washington 25, D. C.

able to reach beyond the confines of his own planet. As yet we can have no clear idea where this type of exploration may lead.

However, the logical thing is to limit our declared goals to immediate exploration of the new region of space which is now available, to study it carefully and make a sound determination of the value and feasibility of further steps in exploration and travel.

It must be recognized at once that this is a large and complicated undertaking. In order to succeed we must carry on highly competent research and development in the perfection of various types of rockets and rocket systems, the vehicles to be transported, and maintain close observation and tracking of these vehicles; if possible, communicate with them, which would be another step.

We must likewise continue to push forward research into the most effective means of communication with space vehicles and into their recovery or the recovery from them of their packages of one sort or another, which are the result of observations they make.

Scientific observations made from all types of space vehicles such as rockets, satellites of the type already launched, space platforms, etc., will be of very great importance.

Among the fields of science which will profit tremendously by the use of space vehicles beyond our atmosphere are thorough observations of the sun, which include analysis of the light, heat, radio waves and X-rays from the sun, together with study of the various particles, electrified and otherwise, which may be emitted from the sun.

These are highly important in our analysis of conditions upon the earth, specifically since these observations and analyses are certain to have a profound effect upon such matters as our knowledge of weather and climate on the earth and their fluctuations and upon radio communication.

As a matter of fact, of course, we are entirely dependent on the sun and always have been. The more we can know about the nature and behavior of the sun, the better off we are with respect to our whole environment. The sun and the earth are what scientists would call a system, a giant engine in which the sun delivers heat and many things to us and this fluctuates somewhat. The earth receives it in part and reflects it away in part, so our fundamental knowledge of what goes on in the earth is necessarily conditioned by our knowledge of the sun.

In the past this knowledge has been very imperfect indeed because we only see the sun as though through a dark glass; namely our own atmosphere, which lets through the visible light that our eyes have become adapted to see but stops nearly everything else from the sun.

Therefore, we must get outside this blanket before we can really have a clear idea of what the sun is composed of and about its behavior.

More generally speaking, full knowledge of what the sun sends to us will in time undoubtedly make possible advances in our fundamental knowledge of our earth and the history and future of the solar system.

Similar observations which are essentially astronomical in nature will be highly significant in the study of the planets in our solar system and the stars in our galaxy and the other galaxies.

In fact, undoubtedly the most important opportunity that astronomy has ever had will be the setting up of a fair-sized astronomical telescope on a space platform so as to observe the heavenly bodies

for the first time clearly and without interference from our atmosphere, and to study their complete spectra in detail.

Other observations of great importance concern the detailed study of the magnetic field of the earth and its variations, the existence and location of streams of electrified particles in our neighborhood, and the detailed study of the shape of the earth and the distribution of its mass, which comes from accurate tracking of satellites.

Finally, observations of our planet itself from this distant vantage point will undoubtedly prove to be of great advantage to our fundamental theories concerning weather and climate.

This comes from such observations as the extent of cloud cover over the entire earth and its variations, the location and behavior of storms, especially violent ones such as hurricanes and the like.

Of great importance to space exploration will be studies of the existence and behavior of clouds of cosmic dust, micrometeorites, or other foreign bodies; and of course the study of cosmic rays and other effects which may be damaging to the contents of space vehicles, whether instrument or human.

I should like to point out that the scientific interest, of course, is very high in this type of observation, from space platforms and various types of space travel. Take, for example, what I mentioned about the study of distant stars, the most distant galaxies millions of light-years away.

As you know, a light-year is the distance light travels in 1 year going at the rate of 186,000 miles a second. These galaxies are not involved in space travel obviously because we cannot start out to move even with the velocity of light, much less travel for a million years. But this research is most important to astronomers and, as such, these observations to be made from space platforms fit into the general subject of astronomy together with the whole field we are now studying, radio astronomy and other types of astronomy, so this forms an important niche in our whole present field of astronomy.

The same thing is true of cosmic rays. Now cosmic rays are important to study for the sake of space exploration and travel because, if too intense, they may damage the instruments or the materials of the space platform.

That must be looked into. They also may be extremely dangerous to possible passengers. Now, those are practical reasons. Apart from that, if we can get out in outer space, as we can and are doing now, and study the nature of the cosmic rays in detail, the sizes of the particles, what kinds, how fast they are going, what they are doing, this becomes a part of theoretical physics, nuclear physics which we want to know more about.

In this way the observations to be made from the space platform are very important for the study of science as a whole, and the part played by these observations will take its place among the general interests in fundamental science. Those are quite important reasons.

Thus it is seen that space exploration will involve essentially two types of research which merge one into the other: (*a*) Research which is necessary to the accomplishment of space exploration; and (*b*) pure research employing space vehicles as observing stations.

Both types are involved in the present IGY satellite program and in those which are planned for continuation.

As you know, the National Science Foundation has had the responsibility on behalf of the United States Government for securing and administering the funds for the scientific programs in the International Geophysical Year, including the satellite program, and for the coordination of this scientific work by Government agencies, while the general operation of the United States IGY program has been in the hands of the United States National Committee for the International Geophysical Year in the National Academy of Sciences National Research Council which also provides coordination with other countries.

From what I have said, it will be noted that the opportunities provided by space exploration will be very strongly scientific in character and civilian rather than military, although, of course, military requirements form a part of any general program, and are reported in their own right.

For these reasons, may I repeat my strong conviction that the program, except for its military portion, should be in the hands of a civilian organization such as proposed in the present bills.

Because of its past responsibilities with respect to the purely scientific aspects of studies in outer space and because of its general responsibilities for basic research in the sciences, the National Science Foundation expects to cooperate in the planning and execution of basic scientific research which may be carried out by the use of space vehicles devised by the new Agency.

This would be in accord with Executive Order 10521 which outlines responsibilities of various agencies for the support of basic research and is exactly what we understand the bill contemplates.

The CHAIRMAN. Doctor, at the opening of your statement you say, "I heartily endorse the general outline" of several bills. What about your specific views on them?

Dr. WATERMAN. That was intended to be a rather wholehearted endorsement of the present bills, Mr. Chairman. I do not see there are many details that one might find fault with. It perhaps is a large board which is authorized to advise the Director for quick decision and management, and there it is a matter, of course, of the balance of representation on the board and the difficulty of dealing with a large body or securing a quorum in a large body.

Matters of that sort are matters of opinion and I think can be solved quite well when the new Agency faces its responsibilities.

The CHAIRMAN. Will there be any duplication of work on the part of this new Agency with the National Science Foundation? Will it be in competitive fields?

Dr. WATERMAN. I think not, sir. As I stated at the end of my statement, the National Science Foundation would expect to cooperate fully with this Agency in view of its responsibility for general scientific research of a basic nature and the fact that we have already been following this in the current IGY program. So one could be sure of our cooperation with this Agency, Mr. Chairman.

The CHAIRMAN. With the establishment of an agency along the outlines of the bill, do you understand that some of the activities of the National Science Foundation would be taken over by the new Agency?

Dr. WATERMAN. We would have no responsibilities specifically with respect to any such things as developing space vehicles, rockets, guidance, and the usual things, and the research going with that.

The area where we might cover the same kind of ground is in the matter of research performed by the space platforms. There, quite clearly, this Agency would be responsible for research related to the means of exploring space, the environment in which the vehicles travel, the effects that would have to be discovered to find out if anything would interfere with their flight.

The possibilities of traveling to the moon, say, or ultimately to another planet would have to be things they deal with. There would have to be basic observations with respect to that.

We, too, are interested in that, but not from the standpoint of space exploration—rather from the standpoint of the knowledge of science, what is contributed by such observations, as illustrated by the telescope I mentioned which could be mounted on a space platform.

The new State Agency would be interested in precise observations concerning bodies that might be approached or are to be reached in space exploration and what sort of conditions would be encountered.

We, on the other hand, would find that in our astronomy program similar information would be very welcome to the astronomers and observations of very distant stars, places where there is presently no possible hope of every traveling those distances.

In those cases we would expect to include such research in our general program and advise and cooperate with the new Agency in that territory.

Whether this needs to be spelled out, Mr. Chairman, any further is a matter of your decision, of course.

The CHAIRMAN. I note from your statement that the National Science Foundation has been designated as a representative of the United States during the IGY year.

Dr. WATERMAN. Yes, sir.

The CHAIRMAN. If this new Agency is established, would you expect the new Agency to represent the United States or the National Science Foundation?

Dr. WATERMAN. I have heard no mention of the new Space Agency taking such a part. Of course, it is not in existence yet. But the present discussions among the different nations have been as follows: that the international body concerned with the International Geophysical Year, has decided against continuing the International Geophysical Year.

At the same time, they have had under active discussion suitable programs that could be considered after the IGY. Among those is this matter of space research. Another is oceanography. Another is research in the polar regions.

Those may come to a head and we may be asked whether the United States would become a party to similar programs in special areas as a matter of continuing operations rather than just for one particular year like the IGY.

Space research is one of those. Since the National Science Foundation is already involved in the IGY space research program we could act in a similar capacity with respect to that, if the situation arose again, just as we might in other areas of cooperative international research.

Now, if that happened, there would have to be, of course, an understanding between us and the new Agency as to just who would handle this and how.

The CHAIRMAN. What is Executive Order 10521, Doctor?

Dr. WATERMAN. That is an Executive order of the President, dated 1954, entitled "Executive Order Concerning Government Scientific Research, the National Science Foundation, and the Interdepartmental Committee for Scientific Research and Development." In effect it is an Executive order which clarifies the responsibilities of Government agencies in the field of basic research and in scientific research and development.

The CHAIRMAN. Do you have an extra copy there?

Dr. WATERMAN. Yes, sir.

The CHAIRMAN. Without objection, it may be inserted in the record at this point.

(The document follows:)

[Reprinted from the Federal Register of Friday, March 19, 1954]

MARCH 17, 1954—EXECUTIVE ORDER CONCERNING GOVERNMENT SCIENTIFIC RESEARCH, THE NATIONAL SCIENCE FOUNDATION, AND THE INTERDEPARTMENTAL COMMITTEE FOR SCIENTIFIC RESEARCH AND DEVELOPMENT

TITLE 3—THE PRESIDENT

EXECUTIVE ORDER 10521

ADMINISTRATION OF SCIENTIFIC RESEARCH BY AGENCIES OF THE FEDERAL GOVERNMENT

Whereas the security and welfare of the United States depend increasingly upon the advancement of knowledge in the sciences; and

Whereas useful applications of science to defense, humananitarian, and other purposes in the Nation require a strong foundation in basic scientific knowledge and trained scientific manpower, and

Whereas the administration of Federal scientific research programs affecting institutions of learning must be consistent with the preservation of the strength, vitality, and independence of higher education in the United States; and

Whereas, in order to conserve fiscal and manpower resources, it is necessary that Federal scientific research programs be administered with all practicable efficiency and economy; and

Whereas the National Science Foundation has been established by law for the purpose, among others, of developing and encouraging the pursuit of an appropriate and effective national policy for the promotion of basic research and education in the sciences

Now, therefore, by virtue of the authority vested in me as President of the United States, it is hereby ordered as follows:

SECTION 1. The National Science Foundation (hereinafter referred to as the Foundation), shall from time to time recommend to the President policies for the Federal Government which will strengthen the national scientific effort and furnish guidance toward defining the responsibilities of the Federal Government in the conduct and support of scientific research.

SEC. 2. The Foundation shall continue to make comprehensive studies and recommendations regarding the Nation's scientific research effort and its resources for scientific activities, including facilities and scientific personnel, and its foreseeable scientific needs, with particular attention to the extent of the Federal Government's activities and the resulting effects upon trained scientific personnel. In making such studies, the Foundation shall make full use of existing sources of information and research facilities within the Federal Government.

SEC. 3. The Foundation, in concert with each Federal agency concerned, shall review the scientific research programs and activities of the Federal Government in order, among other purposes, to formulate methods for strengthening the administration of such programs and activities by the responsible agencies, and to study areas of basic research where gaps or undesirable overlapping of support may exist, and shall recommend to the heads of agencies concerning the support given to basic research.

SEC. 4. As now or hereafter authorized or permitted by law, the Foundation shall be increasingly responsible for providing support by the Federal Govern-

ment for general-purpose basic research through contracts and grants. The conduct and support by other Federal agencies of basic research in areas which are closely related to their missions is recognized as important and desirable, especially in response to current national needs, and shall continue.

SEC. 5. The Foundation, in consultation with educational institutions, the heads of Federal agencies, and the Commissioner of Education of the Department of Health, Education, and Welfare, shall study the effects upon educational institutions of Federal policies and administration of contracts and grants for scientific research and development, and shall recommend policies and procedures which will promote the attainment of general national research objectives and realization of the research needs of Federal agencies while safeguarding the strength and independence of the Nation's institutions of learning.

SEC. 6. The head of each Federal agency engaged in scientific research shall make certain that effective executive, organizational, and fiscal practices exist to insure (a) that the Foundation is consulted on policies concerning the support of basic research, (b) that approved scientific research programs conducted by the agency are reviewed continuously in order to preserve priorities in research efforts and to adjust programs to meet changing conditions without imposing unnecessary added burdens on budgetary and other resources, (c) that applied research and development shall be undertaken with sufficient consideration of the underlying basic research and such other factors as relative urgency, project costs, and availability of manpower and facilities, and (d) that, subject to considerations of security and applicable law, adequate dissemination shall be made within the Federal Government of reports on the nature and progress of research projects as an aid to the efficiency and economy of the overall Federal scientific research program.

SEC. 7. Federal agencies supporting or engaging in scientific research shall with the assistance of the Foundation, cooperate in an effort to improve the methods of classification and reporting of scientific research projects and activities, subject to the requirements of security of information.

SEC. 8. To facilitate the efficient use of scientific research equipment and facilities held by Federal agencies:

(a) the head of each such agency engaged in scientific research shall, to the extent practicable, encourage and facilitate the sharing with other Federal agencies of major equipment and facilities;

(b) a Federal agency shall procure new major equipment or facilities for scientific research purposes only after taking suitable steps to ascertain that the need cannot be met adequately from existing inventories or facilities of its own or of other agencies; and

(c) the Interdepartmental Committee on Scientific Research and Development shall take necessary steps to insure that each Federal agency engaged directly in scientific research is kept informed of selected major equipment and facilities which could serve the needs of more than one agency. Each Federal agency possessing such equipment and facilities shall maintain appropriate records to assist other agencies in arranging for their joint use or exchange.

SEC. 9. The heads of the respective Federal agencies shall make such reports concerning activities within the purview of this order as may be required by the President.

DWIGHT D. EISENHOWER.

THE WHITE HOUSE,
March 17, 1954

The CHAIRMAN. What are your views regarding the Director as proposed in this bill and the commission form of agency?

Dr. WATERMAN. That is always a problem in connection with an agency of this kind. There is a tendency for an agency devoted to science to have a commission form because of the greater opportunity for review and discussion of policies and actions.

My own view in this case is that since this is a very urgent matter, if the United States wants to go into space research, and is really determined to make progress, then you really have a mission on which you have to put a great deal of emphasis and drive, and the right way to do it is to have an agency where the director really has the authority and has a board behind him to consult.

In other words, the importance of this job seems to me to indicate that there should be a director with an advisory body rather than a commission. That is my personal view.

The CHAIRMAN. Do you mean important so far as the immediate year or 2 or 3 years—the immediate period ahead?

Dr. WATERMAN. Especially during the years ahead. But this is going to be a very difficult undertaking and it seems to me this importance justifies doing it in a manner which will enable decisions to be made quickly and wisely and with no delay in getting on with the work.

The CHAIRMAN. What is the difference between a director with a board of 17 to advise him—they would have a lot of influence, I am not deceiving myself on that—and the commission form of 5?

I think you would have more expeditious action with a commission of five rather than a board. You have to view this board in the light of history. Now and heretofore they are the top level of management, and they are over the director.

You have that history of thirty-odd years. It is pretty hard to depart from it.

Dr. WATERMAN. Well, this is a debatable matter. There are advantages to both types. The advantages, as you have said, of the commission is that you reduce the decisions to a smaller group. Nevertheless, the group has to make them as a group in the commission type.

In the case where you have a director and an advisory board, the advisory board is after all advisory only. While its advice may be taken very seriously by the director he can, in principle, act rapidly if he has to, and that is the thing which the commission form cannot do quite so well.

The CHAIRMAN. I am inclined to think there is a lot of substance in what you say, in starting out with something new. I doubt very much if it was a new idea that you would have an advisory board of 17. The only strength in favor of it is the historical aspects, so far as I am concerned, and recognizing the exigencies in connection with departure from the historical background of the NACA. But I would imagine this Board would be more than advisers in the new setup.

I think they will have a much more potent effect than just being advisers, having in mind that they have been the bosses for 30-odd years, but I will not ask you about that.

Dr. WATERMAN. I can understand that. You will notice I did say I felt that a board of 17 seems unduly large. I know that is only authorized. My hope is that it would be smaller than that because then it would be much more manageable.

The CHAIRMAN. Of course if we provide for 17, they will have 17, because 8 come from Government departments and agencies and you have to have a majority from outside the Government agencies to maintain the civilian characteristic of the agency.

We can provide it shall be a civilian agency, but everything else we do might make it otherwise.

Dr. WATERMAN. Yes.

The CHAIRMAN. Doctor, have you given consideration as to the military function within its probable field as we view the world today and the immediate future, what there is left for this agency to do other than by permission of the Defense Department?

Dr. WATERMAN. I think they have a great deal to do. After all, the field is wide open in this space research game. The possibilities are very much greater than any the Department of Defense, at least in my opinion, should do.

The CHAIRMAN. The Defense Department might hold that the sending up of satellites is primarily military. Then you realize under the terms of the bill the military makes the decisions, does it not, unless we change the language?

Dr. WATERMAN. If they say that a thing is military in nature, then they have the authority for that part of it. So it depends on how much they claim is military, is that right?

The CHAIRMAN. Suppose there is a difference of opinion between the new agency, whatever it is, and the military? Have you an opinion to express whether they ought to be able to have it resolved by someone else, such as the President?

Dr. WATERMAN. This would have to come to the President, undoubtedly with the advice of his chief adviser on science and technology, Dr. Killian, in my opinion.

The CHAIRMAN. If the new agency said a particular scientific program was essentially a civilian field and the Defense Department says essentially the same program is in the military field, there is a clash.

Should there not be some source of decision as to which one is right?

Dr. WATERMAN. It can only be the President, it seems to me, with such advisory counsel as he has.

The CHAIRMAN. Should there be language in the bill that provides for that?

Dr. WATERMAN. That would be, of course, according to the wishes of Congress, whether there is need for this to be spelled out or whether it would happen anyway. It seems to me that it would happen in any event.

The CHAIRMAN. Now, in your agency are your scientists and technicians under the Classification Act?

Dr. WATERMAN. Most are, but we have authority for exceptions to the civil service regulations in our act.

The CHAIRMAN. Under the bill, this new agency would be excluded, would it not?

Dr. WATERMAN. I believe it has that power, sir.

The CHAIRMAN. What effect would that have on you in relation to those associated with you who are not outside the Classification Act?

Dr. WATERMAN. I don't think that would bother us. You see, we do have the power to make exceptions as well. That takes care of our top positions in the agency.

The CHAIRMAN. You do have the power?

Dr. WATERMAN. Yes, sir.

The CHAIRMAN. With similar language along the lines of that contained in the bill?

Dr. WATERMAN. It is along similar lines.

The CHAIRMAN. When you review your remarks will you put the language in, Doctor?

Dr. WATERMAN. Yes.

(The information follows:)

PROVISION OF THE NATIONAL SCIENCE FOUNDATION ACT OF 1950 RELATING TO APPOINTMENTS WITHOUT REGARD TO THE CLASSIFICATION ACT OF 1949

SEC. 14 (a) The Director shall, in accordance with such policies as the Board shall from time to time prescribe, appoint and fix the compensation of such personnel as may be necessary to carry out the provisions of this Act. Such appointments shall be made and such compensation shall be fixed in accordance with the provisions of the civil-service laws and regulations and the Classification Act of 1949: *Provided*, That the Director may, in accordance with such policies as the Board shall from time to time prescribe, employ such technical and professional personnel and fix their compensation, without regard to such laws, as he may deem necessary for the discharge of the responsibilities of the Foundation under this Act. The Deputy Director hereinafter provided for, and the members of the divisional committees and special commissions, shall be appointed without regard to the civil-service laws or regulations * * *.

The CHAIRMAN. Mr. Brooks.

Mr. BROOKS. Doctor, thus far have you found that the NACA has worked fairly efficiently?

Dr. WATERMAN. Yes, sir, to the best of my knowledge.

Mr. BROOKS. And this organization would be similar, if we adopt this bill without many amendments, to the NACA organization?

Dr WATERMAN. With this difference about the authority of the director, that is right, sir.

Mr. BROOKS. The director in the bill before us would have much more authority. He would really be the operator.

Dr. WATERMAN. As I understand it, he is appointed by the President, yes, sir.

Mr. BROOKS. He would be akin to a mayor who has a council?

Dr. WATERMAN. In a sense.

Mr. BROOKS. And the director would be the full executive director, subject always to consulting with the President and the board?

Dr. WATERMAN. Yes, sir, that is my understanding.

Mr. BROOKS. The change in your opinion is not enough, is it, to feel that we are going to set up an inefficient agency?

Dr. WATERMAN. I think it would be an efficient agency, because it could and would partake of the efficient management and the excellent work done in NACA. I think it would be strengthened actually by the fact that the President appoints the director instead of the director being appointed by the board and responsible to the board.

This means that if one has to do a job fast and thoroughly, that he can act more readily than if he had to depend entirely on his board.

Mr. BROOKS. It puts the Director closer to the President?

Dr. WATERMAN. Yes, sir.

Mr. BROOKS. Instead of being removed one part, he is closer to the President?

Dr. WATERMAN. That is right.

Mr. BROOKS. And if he were a competent man he would feel that he is able to act independently in emergencies?

Dr. WATERMAN. Subject to wise counsel with the President and the Board.

Mr. BROOKS. He could act independently and with dispatch on his decisions?

Dr. WATERMAN. That is right.

Mr. BROOKS. That is why you think it is superior?

Dr. WATERMAN. That is right, Mr. Chairman.

Mr. BROOKS. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Dr. Waterman, do you believe it would be an advantage both to the NACA and the National Science Foundation if the National Foundation were represented on the Board of 17?

Dr. WATERMAN. I believe it would; yes, sir. It would be a great help in keeping our policies coordinated.

Mr. NATCHER. We have had that suggestion made to the committee. In fact, one of the witnesses today made that suggestion.

Dr. Waterman, the National Science Foundation was established under the basic act of 1950, isn't that correct?

Dr. WATERMAN. Yes.

Mr. NATCHER. Now there is no conflict as between the National Science Foundation and the new Agency that will be established by this bill. Am I correct in that?

Dr. WATERMAN. I believe that is correct. I mentioned our mutual interest in basic research on the part of these space vehicles and that we have an interest which I believe goes beyond theirs. Some basic science would have probably no effect on space travel, but this is a matter to be worked out between us and I think it will be recognized.

I do not know whether this needs explicit recognition in the act or not, but I think it will be understood. We have general basic programs for scientific research.

Mr. NATCHER. If we presented the bill on the floor some Member might ask the question whether duplication would be there and whether or not we were just establishing another agency.

As I understand the basic act under which the National Science Foundation was established, it was authorized and directed to develop and encourage "the pursuit of an appropriate and effective national policy for the promotion of basic research and education in the sciences," and further—

> to initiate and support basic research in the mathematical, physical, and other sciences by making contracts and other arrangements for the conduct of basic scientific research, and to appraise the impact of research upon industrial development and general welfare.

Dr. WATERMAN. Yes, sir.

Mr. NATCHER. Briefly, that is the basic act?

Dr. WATERMAN. Yes.

Mr. NATCHER. In my opinion, there would be no conflict or conflict that would not be worked out so that this Agency could cooperate under the power invested in it by the new act.

Dr. WATERMAN. As long as the Agency understands our position in this matter, I believe there is no problem.

Mr. NATCHER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Dr. Waterman, starting on the bottom of page 1 you have this to say:

> Finally, a civilian-led program would place this country in a position to cooperate with other nations with respect to conquering the problems of space exploration, and would better assure a cooperative world reaction than would an effort conducted by the military.

I certainly agree with the statement in general, but I was wondering if you would elaborate a little further as to the desirability of worldwide cooperation in this field of space exploration and how important it might be in our worldwide relations.

Dr. WATERMAN. I think it is most important. It goes without saying when man succeeds in getting out in a new region like this, that this new region should be subject to cooperative exploring.

All the nations should be free to use it. But in order to take full advantage of the opportunity for scientific exploration of space, the cooperation of the nations that have the capacity to do it, it seems to me, is essential.

Not only that, but it is a means of promoting cooperation and good will which is quite important.

Mr. SISK. Do you see any problem under our present system of classification of information? To what extent do you feel we might be a little freer in the exchange of information, particularly in the field of space research?

Under the military program we are constantly faced with this problem. I was wondering what you think may create a lack of cooperation on a worldwide basis in this particular field.

Dr. WATERMAN. Yes; this is a problem of course. Let me tell you the thinking that went on during the discussion of the IGY satellite program. You will recall that when we considered the United States participation in this program we announced that we would make freely available to all nations the reports of the scientific observations we were going to make, the instruments that did it, and we told just how these instruments would report so they could hear the radio signals from the satellites. We told them what wavelength these would be on and how other nations could pick them up.

But we also told them the launching of these vehicles would be under the Department of Defense and this would be a matter that we would not divulge except to the extent that the military were willing to do so.

So the security problem could be the means of getting the space projectile into its orbit, the extent to which this uses military methods which have to be classified.

Beyond that, it seems to me science leaves this well open and furnishes a very convenient ground for cooperation in just the manner we had planned our original IGY operations.

Mr. SISK. To what extent have other nations participating in the IGY made available to us their scientific findings?

Dr. WATERMAN. There has been very good sharing. In fact, this has been a most agreeable surprise, that the nations have worked so cooperatively.

This has been especially true, for example, in places like the Antarctic Continent where all nations communicated on what they are doing and exchanged scientists. This has taken place throughout the whole program and information is already being pooled.

In the satellite programs there is an agreement that the information be pooled, but due to the nature of receiving the information from the satellite; namely, by radio, which is coded, and because the information comes in in different forms, recordings in scientific experiments have to be interpreted.

It takes a long time not so much to decode these signals, but to analyze them and put them in a systematic manner so that people will understand. So, in the case of satellite operations there will be quite a long delay before the information can be put out in intelligent form.

Mr. SISK. The data have to be evaluated?

Dr. WATERMAN. Yes, and put in shape so that it is intelligible.

Mr. SISK. I have one other question, Doctor. There seems to be a great deal of concern among some people in the scientific field, that there has not been the freedom to engage, let us say, in power research and what we might even call scientific dreaming, to some extent.

Along that line I have received some criticism from rather reputable scientists in this country that the NACA has tended to restrict some of the freedom of the scientific minds.

Now, do you agree or disagree with that, Doctor?

Dr. WATERMAN. I can put this in two ways. To the extent that the mission of the NACA is carried out; namely, the development of aerodynamics and flight through the atmosphere, there have been very good in encouraging new ideas, and they have had a number of them. But this is applied research in the direction of assistance to aviation, flight.

In that respect they have had a number of notable achievements showing that they have left their men plenty of latitude to dream with respect to possibilities. They have not gone so much into the basic research side because that has not been their mission, for example basic research underlying power for rockets.

One might say, if one wanted to be overly critical of the Agency, that they had kept their people thinking about basic research and applied research on the job that the Agency had to do and not wandering out beyond the confines of this work into power science. But this is not their job, and I think they are right.

Mr. SISK. I appreciate your answer, Doctor, because that clarifies a little in my mind some of the criticism I have heard regarding the NACA. In fact, it was worded something like this: that in NACA a person ceases to become a slave to apparatus, a slave to a particular machine and a particular program.

I see now as you analyze it the reason why. Of course, they have specifically planned their programs and apparently some of these people think they are confined to rather narrow lines. When they are working on the program they are not free to have the latitude in order to have their minds wander in the full range of scientific possibilities; is that correct?

Dr. WATERMAN. Yes. This is specified in the Executive order that the Chairman mentioned a little while ago, where after saying the National Science Foundation is responsible for what you might call general purpose basic research throughout science, it goes on to say:

> The conduct and support by other Federal agencies of basic research in areas which are closely related to their missions is recognized as important and desirable, especially in response to current national needs, and shall continue.

So basic research which underlies an understanding of their own problems is entirely legitimate and should be encouraged in every way.

It is most important in my opinion that an agency actually do basic research in the areas which help it out in understanding of its mission.

This is the way that the Agency can achieve its objectives more intelligently and plan its developments more intelligently and with more economy.

Not only that, but this gives their scientists a chance to get recognition as scientists which helps the morale of the organization. It makes certain, too, that the problems they are considering get into an area of science which causes a "feedback" of science into the Agency.

Mr. SISK. You feel that the proposed Agency to be created by legislation now pending would create a better climate for that type of basic research, than, for example, a commission for such as the AEC; is that correct, Dr. Waterman?

Dr. WATERMAN. The action I speak of could take place under either system. It is a little hard to decide on this particular point between the two because in one case you have a large Board which can be helpful in suggesting ideas and in the other a Commission which though smaller would serve full time.

At the same time, the advantage of the system with the director lies in more complete authority, not so much in connection with his use of basic research—he should do that with the advice he gets—but because of the quicker decision making and stronger action he can take where necessary.

Mr. SISK. Thank you, Doctor.

The CHAIRMAN. I may have to leave so I will ask a few more questions.

Doctor, on page 6, line 3, the language is used: "scientific community." What do you understand is meant by the use of the words "scientific community," in this bill?

Dr. WATERMAN. My understanding would be that this means the scientists who have for their life's work the advancement of science, as such.

The CHAIRMAN. Confined to the United States, or worldwide?

Dr. WATERMAN. It could be either.

The CHAIRMAN. In other words, it is not confined to the United States in an arrangement for participation by the scientific community and so forth, but it could be worldwide or regional groups of nations?

Dr. WATERMAN. The immediate thing it seems to me would be to consult our own scientific community. This would be the National Science Foundation for the Government, or the National Academy of Sciences as an agency primarily outside the Government, and through these agencies to the scientists of the country who are concerned with the particular problems that arise.

The CHAIRMAN. Your interpretation is that it is not confined just to the scientific community of the United States?

Dr. WATERMAN. No, it could go further. In the first instance it would be this, but certainly the scientists of other countries would also be involved, especially if there turned out to be the possibility of a cooperative program among nations.

The CHAIRMAN. Is this the only function and responsibility of National Science Foundation, to cooperate with other nations through their scientific community?

Dr. WATERMAN. I cannot think of any other International Cooperation function of the NSF in space research at the moment. Certainly if we are to be engaged in cooperative undertakings with other nations, then this new Agency would be the one to cooperate with respect to the space platform and vehicle programs of other nations.

The CHAIRMAN. Let me call your attention to page 2, the declaration of policy, subdivision 4, line 18:

The preservation of the role of the United States as the leader in aeronautical and space science and technology.

What would this agency have to do in order to perform that duty?

Dr. WATERMAN. It should see that the United States maintains competence in the area to the greatest degree possible.

The CHAIRMAN. I can understand that part. I am asking you to tell the committee what would the agency have to do? Would it have to have an international organization? Would it have to have a CIA of its own? Would it have to have knowledge in order to pass on that, assume some responsibility as to determining how far some other nation has gone?

The preservation of the role of the United States as the leader in aeronautical space science and technology.

There is a lot of relativity to that, is there not?

Dr. WATERMAN. There is.

I would like to point out that if we are going to be the leader in this field, then we should get busy and drive hard on all the things we know how to do best.

If we can hear from other nations, the extent to which we can share information will help us to do that.

But we should avoid the situation where we try to find out what some other countries are doing and then try to beat them in that particular feature.

The CHAIRMAN. Sharing information would not necessarily come within (4) of the bill. The preservation of the role of the United States as a leader involves having complete information intelligence, and everything else, does it not?

Dr. WATERMAN. It does to determine whether we are leading, or not.

But if we are to do a job here we just have to get on with it to the utmost of our ability and hope we will come out as leaders. What more can we do?

The CHAIRMAN. I can understand all that, but I am wondering, if this agency is established, just how in terms of practical operation it is going to perform that responsibility.

Dr. WATERMAN. They must see to it that they have the wisest counsel they can get in the determination of their plans, that they have the best scientific advice that this country can offer and the best intelligence on what scientists are doing in other countries.

Other than that, it is an operating function to get on with it in order to succeed.

The CHAIRMAN. Take (6) of the bill;

The cooperation by the United States with other nations and groups of nations,

and so forth. How would you anticipate the new agency would carry out that point?

Dr. WATERMAN. It could do it by working through the basic and applied sciences in other countries where there is opportunity to do this, to discuss mutual problems.

This gets to be a complex topic which I should like to clear up if I can.

Let me answer by saying this is the way science has worked and always has worked, in an interesting combination of competition and cooperation. If two scientists are working on a similar problem, then each one, of course, wants to get out original work and his reputation depends on it.

So he does his utmost to come out with good research before someone else does.

But, at the same time, it must be original. Now, it cannot be original unless he knows what others are doing. So he confers with others.

Since they are in the same position they have to confer with him. So you find scientists comparing notes on what they are doing and at the same time, when they go home, working hard to come out first, but they are doing both. It seems to me the agency can do both.

The CHAIRMAN. They ought to do more than that in order to carry out the responsibilities of (4) and (6).

Where does the State Department come in? Is that not the Department that has the primary jurisdiction over international affairs?

Dr. WATERMAN. They would certainly be involved in any discussion with other nations.

The CHAIRMAN. You would assume in discussing matters of foreign policy that this new agency——

Dr. WATERMAN. Would work through the State Department.

The CHAIRMAN. Yes. I would even go further, that they would look to the State Department for policy.

Dr WATERMAN. Yes, sir; that is quite correct.

The CHAIRMAN. Do you and your associates feel that this bill is broad enough in that respect?

Dr. WATERMAN. It may need spelling out in the bill; I should think it should be clearly understood that any negotiations for cooperation with other countries should be done through the State Department and with their approval.

There is a similar situation with respect to basic science I spoke about.

The CHAIRMAN. It might be well to spell it out.

Dr. WATERMAN. All right.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Dr. Waterman, speaking about cooperation with other nations in the exchange of scientific information, the State Department has nothing to do with the exchange of scientific data on medicine or chemistry or engineering with foreign countries; does it?

Dr. WATERMAN. Yes, sir. Recently a special scientist was appointed in the State Department, Dr. Wallace Brode, who reports directly to the Secretary of State and this is in his direct province. He is arranging for the setting up of scientific attachés in various countries.

Mr. McDONOUGH. Is this a new function?

Dr. WATERMAN. Yes.

Mr. McDONOUGH. Heretofore, in years past there has been cooperation with German physicians by United States physicians, and with English, French, and Italian doctors. There was no channeling through the State Department on matters of that kind heretofore; is that true?

Dr. WATERMAN. That is true. There are certain exceptions. There are agricultural attachés, military attachés, but this does establish a home for science in the State Department. We, with other countries are cooperating in the exchange of scientific information and in the matter of scientific programs in different countries to make certain that we can set up an exchange that will be valuable to us here. That is done through the State Department. In this the State Department can assist in the normal exchange you refer to.

Mr. McDONOUGH. Suppose an Italian chemist and an American chemist wanted to collaborate on some subject matter and on some basic research, as you said, to find out what the other fellow was doing in order to be the initiator of a new applied science in certain lines. Would that have to go through the State Department for two private individuals?

Dr. WATERMAN. No, because Government policy is not particularly concerned there. What is done between individual scientists in pure science has always been a matter of direct exchange.

Certainly in most countries the State Department would not have to pass on that. The advantage of the new system would be that the State Department could lend a hand and encourage this.

Mr. McDONOUGH. Of course, there would be a disadvantage to the new system, too. Certain information that a foreign country did not want this country to have would not be forwarded to the State Department, and certain information which we did not want the other country to have the State Department could censor, whereas, heretofore, there has been an exchange in the cultural and scientific arts with foreign countries.

I realize that our security is at stake. Where certain things are essential we may have to protect ourselves.

Dr. WATERMAN. There is no cutoff of free exchange contemplated that I know of. Certainly Dr. Brode would be all for encouraging——

Mr. McDONOUGH. I do not mean they are doing that, but it could be a means to that end.

Now this is the International Geophysical Year and, according to your statement, a resolution was adopted by the Geophysical International in 1954 encouraging this Nation to put a satellite in orbit.

You say the United States and Russia picked up the challenge, and we have satellites in orbit.

I understand they have agreed not to continue the International Geophysical Year.

Dr. WATERMAN. As a program, yes.

Mr. McDONOUGH. Suppose when the year is over Russia declares that any nation that puts a satellite in orbit is doing an overt act because it may be used for reconnaissance and surveillance of Russia What position are we in now? Now this is an open season this year, but when the year is over, the scientific data has been compiled, from here on Russia says this is an overt act, what can we do then?

Dr. WATERMAN. This would become a matter certainly of serious United States policy which would have to be considered carefully by the Government—the State Department and the Department of Defense, and so forth.

Mr. McDONOUGH. Insofar as the military operating launching of the satellites, if this new Agency comes into being, do you think it should be the parent agency for basic research and applied science in

space technology for all branches of the Government that are interested in that?

Dr. WATERMAN. Yes, with emphasis on space exploration.

Mr. McDONOUGH. Would that include the operation of the Minitrack station and the other apparatus we have for tracing and launching satellites?

Dr. WATERMAN. Those are essential for space exploration.

Mr. McDONOUGH. That would mean that an agency would then control Cape Canaveral and the launching stations for satellites?

Dr. WATERMAN Not necessarily the military ones. They could use their own.

Undoubtedly they could use the military sites, by arrangement with the military.

Mr. McDONOUGH. We have no launching areas except Cape Canaveral—the others have to be built. But this Agency should build its own for launching and for scientific purposes?

Dr. WATERMAN. I would expect that is ultimately what would happen, sir.

Mr. McDONOUGH. You can see that this National Space Agency, as the bill provides, would also comprehend the National Science Foundation?

Dr. WATERMAN. Comprehend it?

Mr. McDONOUGH. Yes, it would be the parent agency of all scientific organizations in the United States. Would the National Science Foundation be subsidiary to this Agency?

Mr. WATERMAN. Would the National Science Foundation?

Mr. McDONOUGH. Yes.

Dr. WATERMAN. No, indeed. As I was explaining, I think we still have the responsibility for support of basic research and scientific information in the United States.

Our position would be that where the observations from space platforms concern an area of pure science, then this Agency would look to us to work in cooperation on such programs. They would have their own research with which we in turn would not be particularly concerned, and then there would be other areas of research in which both would be interested.

So this is a matter of cooperation, not a matter of rivalry. We would still have our same area of responsibility, in other words.

Mr. McDONOUGH. If this Agency were established, would the National Science Foundation then have, in your opinion, to launch its satellite for its own scientific investigation?

Dr. WATERMAN. No, the launching of the satellite and the machinery to do it with, is the responsibility of this Agency. It is as if we wanted to make some observations from an airplane, then we would have to hire an airplane from an airplane company, or else go to the Department of Defense and ask if we can use theirs in order to get the observations done.

We would arrange to perform the experiment. The experiment would be our responsibility. The provision of the vehicle to do it would be someone else's.

If we had a scientific experiment we wanted very much to do in pure science, we would go to this Agency and say, "Have you a vehicle that can do this and, if so, we would like to make arrangements to get this done as part of your program."

In most cases they would be interested considerably themselves, but if not, this would become a matter of importance to science and we could claim this.

Mr. McDONOUGH. You spoke about the need for learning more about the effects of cosmic rays on space vehicles and on human beings in space. Have not the satellites we have launched given us some pretty good information on that up to now?

Dr. WATERMAN. Yes, but it has not been fully analyzed. Explorer III has a cosmic-ray counter in it and we have been getting observations from that right along. These observations are going to be reported on Thursday at a meeting of the National Academy of Sciences along with the existing observations of satellites to date.

One interesting thing that has developed in this Explorer III is that the cosmic-ray counter at certain points goes blank. Apparently it is overloaded.

Mr. McDONOUGH. Is there an absence of cosmic rays in that area?

Dr. WATERMAN. It cannot be that because it comes to a peak and then shuts off. The mechanism of the counter is such that it can get blocked in that way.

So something is hitting this with considerable intensity and we want to know very much what it is. Until we analyze this further, we won't know for certain.

Mr. McDONOUGH. From what we know of cosmic rays at the present time, will you briefly elaborate on what danger they present to a human being or to metals we know?

Dr. WATERMAN. Yes. The cosmic rays are essentially nuclei of atoms, the same kind of thing we get in the nuclear accelerators, but a greater variety of atoms than we can use in our nuclear accelerators, the artificial machines, and in general tremendously more intense.

Now I am talking about the ones in outer space. Those hit the earth from every direction. Some come from the sun, but only a minor part. In general they are more intense, these primary rays, than anything we can produce in the laboratory.

So nuclear physics is greatly interested in them as one of the primary particles in its studies. As such they cause all sorts of consequences when they strike other nucleii of atoms.

By studying nucleii that are hit by cosmic rays we can determine something about the way the nucleus behaves. These cosmic rays from outer space are so intense they give us results we cannot get from artificial machines.

By doing this in outer space we get the original, primordial cosmic rays before they hit our atmosphere.

After they hit our atmosphere then they begin to cause all sorts of secondary effects in the atoms of our atmosphere, the nucleii of those.

So by the time they get to the earth they are very complicated; a lot of secondary and other particles are produced like electrons, protons, and neutrons.

In outer space we can study these in virgin territory, you might say.

Mr. McDONOUGH. At what elevation would you say?

Dr. WATERMAN. This would be beyond the atmosphere. If you get out, say, 40 or 50 miles, you would be reasonably free from the effects of the atmosphere.

That is all on the physical science side.

On the damage to life, we know that cosmic rays, if intense, can produce injurious effects. The human race has always been exposed to cosmic rays from the earliest times, but it is only to a very slight extent.

In this room at the present time every one of us is exposed to them. Every cubic inch is exposed to 5 or 6 cosmic rays per minute, coming through.

The human race has always been exposed to those. If they are very intense they can cause the kind of damage that penetrating radiation does, such as from reactors.

Mr. McDONOUGH. Deterioration of tissue?

Dr. WATERMAN. Yes, killing tissue and all that.

Mr. McDONOUGH. Do you get a magnification of cosmic rays in intense sunlight?

Dr. WATERMAN. Not in intense sunlight necessarily unless the sun happens to be emitting these cosmic rays. The sun is not a strong emitter. It is only recently we discovered it emitted them at all. They came from outer space.

Mr. McDONOUGH. It is not a particle, it is a ray of light?

Dr. WATERMAN. The original cosmic rays are particles. When they strike other nucleii they cause fragments of those nucleii to go out which themselves hit other nucleii and along with that produce dangerous waves like gamma waves from radioactive materials, intense X-rays and things of that kind. These are effects that are damaging.

At high altitudes they are much more intense than they are at the surface of the ground. That is why we need to look at them carefully there.

Mr. McDONOUGH. Have we been able to simulate cosmic rays in the laboratory to study their effect on materials?

Dr. WATERMAN. Only the ones that are slowed down, you might say, the slow ones that reach the surface of the earth. The ones with terrific energies we cannot come anywhere near simulating.

Our biggest atom smasher is now producing 6 billion equivalent volts. It is shooting electrified particles as though they were shot by a 6-billion-volt machine. That is the most we have been able to do in the laboratory.

Now, the cosmic rays it has been known for some time, do more than that. The number is so much bigger it is almost inconceivable.

Mr. McDONOUGH. In other words, a cosmic ray is a tremendous force that we must know more about?

Dr. WATERMAN. That is right. They are tiny particles and there are not many of them, but we need badly to know more about them.

Mr. McDONOUGH. In other words, a cosmic ray is a tremendous force we know very little about?

Dr. WATERMAN. Yes.

Mr. McDONOUGH. And we want to learn more about it?

Dr. WATERMAN. Yes.

Mr. McDONOUGH. The next important thing for exploration is the magnetic force of the earth in outer space. How far have we gone in our knowledge of that in applied science?

Dr. WATERMAN. Well, both in pure and applied. Of course, the knowledge of the magnetic field of the earth is important in the magnetic compass that we have used over the years.

The trouble with it is that it does not give true north and it varies according to where you are because the earth's magnetic poles are not where the geographic poles are.

Also, it varies in many ways, including a daily variation.

Mr. McDONOUGH. Have we been able to discover the magnetic force of the earth from the satellites we have released?

Dr. WATERMAN. Not directly because we have not yet got our satellite up that will make these magnetic observations.

Mr. McDONOUGH. None of the satellites we have put up have had it?

Dr. WATERMAN. No, what we badly need to know is what the magnetic field of the earth is like away from the earth because it is there the sun has its biggest influence on the earth and that might be shown first in the magnetic field out there.

Mr. McDONOUGH. That is quite a distance away?

Dr. WATERMAN. Yes. We don't know such matters as whether the magnetic field is influenced by streams of electrified particles going around the earth. If such were the case, they would produce a magnetic field on the earth. We would very much like to know if this is part of the picture this stream of electrified particles going around like a big current, producing the magnetic field we see on the earth.

Mr. McDONOUGH. Do we know anything about the magnetic field of our closer planets? Is there such a thing around the moon, or Mars?

Dr. WATERMAN. We would like very much to know whether the moon has a magnetic field. We have no idea really. We suspect it probably has a weak one, but we would very much like to know.

Now, the sun does. Also the particles coming from the sun produce changes in our own magnetic field. When we get showers of electrons from the sun we know this upsets the compass.

Mr. McDONOUGH. This probably has an effect on our thundershowers.

Dr. WATERMAN. It may have.

Mr. McDONOUGH. Thank you very much.

Mr. BROOKS (presiding). Mr. Keating.

Mr. KEATING. I want to ask you a couple of questions about outer space. That is a pretty hard concept for a bunch of Congressmen to get.

What kind of scientist are you?

Dr. WATERMAN. A physicist.

Mr. KEATING. You are the kind that ought to know the most about outer space. If I get up there, or anything else gets up there, in order to stay there it has to keep in orbit and it has to keep moving around at least 18,000 miles an hour?

Dr. WATERMAN. It has to keep that speed if it is at the height of our present satellites. It does not have to go that fast if it is out further.

Mr. KEATING. Even up 100,000 miles it would have to go pretty fast?

Dr. WATERMAN. Yes, indeed.

Mr. KEATING. Suppose I am going around up there and I throw a pan of water out. Does that water go around the same rate I am going?

Dr. WATERMAN. If you threw a pan of water out from a satellite, if the water could stay liquid it would go around with you.

Mr. KEATING. Suppose I toss a ball out, would that go around with me?

Dr. WATERMAN. Yes, but of course, the water would evaporate instantly.

Mr. KEATING. Anything that is detached from anything else that is going around up there, will go around at the same speed?

Dr. WATERMAN. Yes, you cannot drop anything from a satellite. If you put it out of the window, if you could, it would just go around with you.

Mr. MCDONOUGH. Which you could not do?

Dr. WATERMAN. Not without some mechanical trap-door arrangement to do it.

Mr. KEATING. You cannot put anything below you or above you without some propulsion apparatus?

Dr. WATERMAN. That is correct.

Mr. KEATING. If you had a propulsion apparatus you could do that.

Dr. WATERMAN. You would have to either push it or have a device like a little rocket which will give it speed.

The only way that we know clearly for propelling anything in outer space is by the rocket principle; that is, by sending something in one direction which makes you go in the other direction.

Mr. KEATING. Now, what is the distance to the nearest star?

Dr. WATERMAN. The nearest fixed star is about 4 light-years which means that light traveling 186,000 miles a second would take 4 years to get there.

Mr. KEATING. Then it is a figure of miles from here that is almost impossible to comprehend?

Dr. WATERMAN. That is exactly right.

Mr. KEATING. Then is that why we talk all the time about interplanetary travel?

Dr. WATERMAN. The planets are distinguished from the stars.

Mr. KEATING. How near to the sun are the planets?

Dr. WATERMAN. We are 92 million miles from the sun.

Mr. KEATING. That is not the nearest planet to the sun?

Dr. WATERMAN. No; the nearest is Mercury.

Mr. KEATING. How far is that?

Dr. WATERMAN. About one-third—36 million miles.

Mr. KEATING. It is going to take us, according to the story we got, 4½ days, roughly, to go 240,000 miles to the moon.

Dr. WATERMAN. This depends on the speed, of course. The moon is only 240,000 miles away. You might be able to reach that in a matter of hours, like 8 or 10 hours.

Mr. KEATING. The figure I was given by the Army is 4½ days.

Dr. WATERMAN. This depends on how fast you want to travel.

Mr. KEATING. It is fast enough for me.

Dr. WATERMAN. If one is trying to go to the moon and by it out into space, then you could go a lot faster. But if you want to go and land on the moon, then you don't want to go too fast because you want to simplify the problem of landing softly. So that would take you longer.

Mr. KEATING. Does this talk about interplanetary travel presuppose that we are going at much greater speeds than 240,000 miles an hour.

Dr. WATERMAN. We don't know. Of course, we would like to be able to, and with present techniques we could step this up considerably, I don't know just how far. When you do, of course, you complicate the problem of slowing up at the other end if you want to land.

But the fact is that it takes a long time to get to another planet, really a long time, a matter of a year or so perhaps, by the speeds we are talking about.

Mr. KEATING. Let me ask you this question: You talked about light-years. You said that we would never be doing this traveling to these stars because they are many millions of light-years away?

Dr. WATERMAN. In the case of most of the galaxies that is true.

Mr. KEATING. We had a fellow that said if you go 95 percent of the speed of light, or the speed of light, time does not count. Why can't you go up there and spend 10 million years and come back here and be the same age you are today?

Dr. WATERMAN. Perhaps you can, but by the same token time here would be 10 million years hence. Who knows if, when man got back, we would still be here or anything like us. Maybe the earth wouldn't exist.

Mr. KEATING. It is a theoretical matter. If you got going as fast as the speed of light you could go up there and stay almost forever and come back here and you would be no older than you are now; is that right?

Dr. WATERMAN. There are two theories about this. The plain fact is, as you were saying, we believe that we cannot go faster than the velocity of light.

We also know that to try to go anywhere near the velocity of light takes a prodigious effort. The closer you get to the velocity of light the harder it is to go any faster. Your mass increases and you have to be pushed terrifically to do it. Nobody has solved whether we can stand that kind of acceleration. If one could get to the velocity of light time apparently would stand still.

But I have not heard the specialists say that they are sure whether if you did this then time would stand still and when you came back you would be "behind time" in this sense. There is a school of thought which says "No, this cannot be right; nature would not act that way. When you come back you would join on to life as you had it before."

But the experts have not decided this.

Mr. KEATING. When are they going to decide that?

Dr. WATERMAN. We have had no good opportunity to make experiments on that. It would be a hard thing to work out.

Mr. KEATING. Of course, if you go up there and stand still for a million years and come back here, it is no good unless you take your friends with you.

Dr. WATERMAN. I expect not.

Mr. KEATING. Well, it is fascinating to me.

Dr. WATERMAN. Yes; it is to anyone.

Mr. KEATING. And we appreciate having someone here to clear up our minds, or, at least, cause greater confusion.

Thank you.

Mr. BROOKS. Mr. Fulton.

Mr. FULTON. Your agency has been participating in the International Geophysical Year and has been doing a good job. We want to compliment you.

Would you put a statement in the record of the history of the participation of your agency in the International Geophysical Year?

Dr. WATERMAN. I shall be very glad to.

Mr. FULTON. Likewise the calendar of events that you intend to complete during the year?

Dr. WATERMAN. Fine.

Mr. FULTON. Would you also tell us on the committee of this meeting of the National Academy of Science, where the three scientists are going to give out statements on the United States participation with our Vanguard and Explorer satellites? Can you tell us where that is and is it going to be open to the public.

I am really asking so that the public will know.

Dr. WATERMAN. It is in the National Academy of Sciences in their great hall.

Mr. FULTON. It is open to the public?

Dr. WATERMAN. I believe so.

Mr. FULTON. I know it is, and I am trying to make it public. Are those statements that are being prepared for this Academy of Science on Thursday available now?

Dr. WATERMAN. Some have been already published. Perhaps you will recall there was an article in Science recently, about the first of February, giving a summary of the highlights of the International Geophysical Year to date.

Quite a lot is in that.

Mr. FULTON. Could we put that summary in the record at this point, if you would provide us with that?

Dr. WATERMAN. Yes, indeed

(The summary mentioned above is as follows:)

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INTERNATIONAL GEOPHYSICAL YEAR—A REPORT ON THE UNITED STATES PROGRAM

Hugh Odishaw [1]

The International Geophysical Year began on July 1 and will continue through all of 1958. This article presents a brief account of some of the activities during the first 5 months, July 1 to November 30, 1957.

Although this account is primarily concerned with the United States program, some references are made to the activities of other participating countries. It should be noted that 67 countries are cooperating in this study of the earth and its cosmic environs; the types of work described here are also being conducted by other national IGY groups. For the convenience the IGY investigations may be classified under three categories: (i) the physics of the upper atmosphere, (ii) the earth's heat and water regimen, and (iii) the earth's structure and interior. Subjects in the first category include solar activity, aurora and airglow, cosmic rats, ionospheric physics, and geomagnetism. This category also includes rockets and satellites, tools for sending instruments into the upper atmosphere. Subjects in the second category include meteorology, oceanography, and glaciology, and those in the third include seismology, gravity, and determinations of longitude and latitude.

The following sections report briefly the activities in each of the fields in each of the three categories. A final section outlines aspects of the collection and interchange of data in the IGY program.

PHYSICS OF THE UPPER ATMOSPHERE

Solar activity.—As particles radiated from the major solar flare of June 28, 1957, began to arrive at the earth, 2 days later, a storm wracked the earth's magnetic field. The ionosphere—the layer of electrically charged gas between

[1] The author is executive director of the U S National Committee for the International Geophysical Year of the National Academy of Sciences, Washington, D. C.

about 40 and 200 miles above the earth's surface—was torn by electrical disturbances; long-range radio communication was blacked out for a long period of time. The flare was first observed at the Krasnaya Pakhra Observatory in the Soviet Union. Immediately a message was flashed to the World Warning Agency operated for the IGY by the National Bureau of Standards at Fort Belvoir, which declared a state of alert beginning at 1600 universal time, June 28. Alerts are declared when there is probability of solar disturbances. When the possibility is high that terrestrial disturbances will also occur, special world intervals are promulgated, calling for an increased number of measurements of solar-terrestrial phenomena. The first such interval in the IGY was declared June 29, to commence at 0001 universal time on June 30. Throughout the world observations of the sun were intensified, and balloons and instrumented rockets were sent up by many nations to observe the increased ultraviolet and X-radiation and to monitor cosmic-ray intensity. Observations and measurements were speeded up to record more carefully and fully the northern and southern lights, to measure disturbances in the earth's magnetic field, and to probe the ionosphere.

During periods of maximum solar activity radio communications are often interrupted by fadeouts or blackout, particularly after the occurrence of a flare on the sun. On these occasions pulses transmitted to the ionosphere by ionospheric sounders are not reflected as usual but are absorbed. It had long been thought, but not heretofore conclusively established, that this absorption must be caused by increased ionization in the lower atmosphere. On July 4, radio signals received from a rocket fired up through the ionosphere demonstrated the presence of an additional layer of ionization extending for about 12 miles below the normal lowest point. Even more remarkably, the rocket data showed that the normal ion distribution throughout the ionosphere above the D, or lowest, layer, seemed to remain undisturbed during the blackout In another recent IGY rocket experiment, it was ascertained that the additional electron layer was caused by solar X-ray emission associated with the occurrence of solar flares.

Rockets are only one means of studying solar phenomena. Solar astronomers have organized themselves in a worldwide solar patrol, keeping watch on the sun all over the world throughout the 24 hours of the day. Solar observation stations are operated by 33 countries; of 126 stations all over the world, 14 are operated by the United States, not including rocket-firing sites.

By observing the sun through special filters which limit transmission to the light of certain radiations of hydrogen or calcium, astronomers look for the giant eruptions or flares on the sun which are responsible for radio blackouts, auroras, and magnetic storms. Very narrow band filters are used, since the flares would otherwise be invisible against the bright surface of the sun.

Special instruments are also in use to photograph the chromosphere of the sun, a shell of very incandescent gas just above the sun's surface, and the corona, an envelope of gas that may extend all the way to the earth. The chromosphere and corona are invisible except when an eclipse shuts off the light of the disc, or when the sun is artifically eclipsed in a special telescope called the coronagraph.. Using the coronagraph, scientists are able to photograph solar flares at the edge of the sun; these flares sometimes shoot out into space for several hundred thousand miles at very high speeds.

At Mount Wilson Observatory in California, measurements are being made of the magnetic field of the sun at its surface It has already been found that magnetic fields at the sun's surface may be very high, as much as 8,000 times that of the earth's field at the equator. These magnetic fields are thought to play a very important role in disturbances and storms on the sun's surface as well as in sunspots.

Geomagnetism.—Thirty countries throughout the world are operating 129 magnetic observatories, from the North to the South Pole and in almost every region of the earth's surface; 31 of these stations are part of the United States program in geomagnetism.

Newly established United States IGY geomagnetic stations are in operation in the Arctic, in the Pacific Ocean, in continental United States, and in South America with the cooperation of IGY scientists in Peru. Certain of these stations are set up in chains, with carefully planned spacing, to study in detail the magnetic storms which occur during great solar disturbances It has been suggested, but not before positively established, that the magnetic effects we observe on earth during magnetic storms may be due to great electric currents, of perhaps several hundred thousand amperes, flowing around the earth high in the atmosphere. Two of these currents are believed to circle the North and South magnetic poles, while the third circles the earth at the geomagnetic equator. This theory is being examined.

The stations in South America and in the Pacific Ocean—at Guam and Koror in the western Pacific and at Jarvis, Palmyra, and Fanning Islands in the eastern Pacific—were established especially to study the existence of the so-called electrojet. The electrojet is believed to be the equatorial electric current, but narrowed down into a neck of limited horizontal dimensions with consequent increased current density and intensified activity at local noon. The United States Coast and Geodetic Survey, which operates many of the magnetic observatories established by the United States, reports tentative confirmation of this phenomenon. Initial data from Koror reveal the existence of the equatorial electrojet and its rather limited horizontal extent.

Aurora and airglow.—A worldwide comprehensive auroral observation program in 49 countries is under way for the first time during the IGY. Many of these 49 countries are in low latitudes where auroras are seldom seen. Nevertheless, in all of them, auroral reporters have been appointed to collect reports of visual observations in the event that a very great aurora should occur. A number of such auroras have been reported in the last century, but these events of great scientific importance have usually been inadequately described. One hundred and forty-two camera and instrumental auroral observation stations, as well as extensive amateur visual observing programs, have been organized in 17 countries.

The 39 stations and hundreds of amateurs participating in the United States program have already had much to observe. The fact that the IGY was scheduled for a period of expected maximum solar activity has greatly enhanced the value of the program, for already three of the largest solar flares (class 3+) have resulted in extensive auroral displays visible as far south as Havana, Cuba. Synoptic maps have been prepared depicting all auroras observed and reported from the United States during the months of July and August. This is the first time that such a complete description of auroral data has been assembled for the use of geophysicists studying auroral and such related phenomena as ionospheric and geomagnetic effects.

English scientists at the University of Manchester have reported that simultaneous radar observations indicate that auroras occur simultaneously in the Northern and Southern Hemispheres, a condition long believed to be true by scientists, but not previously established Additional polar radio data which provide further evidence on this question have been obtained in the United States program.

The systematic reduction of the variations in the intensity of the night airglow is proceeding. Charts of the patchiness and movement of night sky luminosity resulting from oxygen emissions are being produced on a routine basis from IGY observations.

Ionospheric physics.—One of the major problems in ionospheric physics is predicting the future state of the ionosphere. If we can determine the condition of the ionosphere in advance, we can do much to develop more reliable radio communications, with direct rewards in safer travel in the air and at sea. Forty-one nations are conducting studies of the ionosphere during the IGY, and a worldwide network of 253 ionospheric observing stations has been established. Seventy-one of these stations are sponsored by the United States. The data obtained by the network will provide a worldwide picture of the behavior of the ionosphere.

New information about the farthest reaches of the atmosphere is being obtained from the study of whistlers—whistlelike sounds which can be detected at very low radio frequencies. These signals, originating in lightning flashes as the surface of the earth, swing out thousands of miles along the earth's lines of magnetic force before they return to the opposite polar hemisphere. Early IGY experiments demonstrated that the ion density and molecular concentration along the whistler path at altitudes of as much as twice the earth's radius must be much greater than formerly anticipated. Indeed, there seems to be confirmation for the theory that the earth's atmosphere extends far beyond the level where it had been previously thought to end and that there may be a very tenuous atmosphere—the sun's corona— filling all the space between the earth and the sun.

Other records of previously unexplained radio noise at very low frequencies have stimulated the hypothesis that solar particles arriving in the very high atmosphere transfer energy to very low frequency radio waves there. According to this hypothesis, the radio signals thus amplified are the very low frequency radio emissions observed at ground level. Data now being gathered will throw further light on this hypothesis, which is based on the traveling wave tube principle noted by Roger Gallet.

Ionospheric characteristics are deduced from the analysis of echoes arising from the reflection of radio pulses transmitted to the ionosphere at vertical

incidence. Since the IGY began there have been several major solar events that caused disruption of long-range, shortwave radio communications which depend upon reflections from the ionosphere. For the first time, a synoptic picture has been obtained of the growth and decay, station by station, of such fadeouts.

The principal regular variation in the ionosphere is the diurnal one. Ionization density increases during the day when the sun is present and decreases at night. What would happen to the ionosphere during long absences of solar radiation and the nature of any diurnal variation that might occur during such periods have been subjects of speculation. Only at or near the geographical poles can these questions be examined, and the South Pole affords the best platform for an observatory. Investigations during the last year at the United States South Pole Station have yielded interesting results: In spite of the absence of the sun, the electron concentration seems to remain very high throughout the polar night; moreover, there is a diurnal variation that can only, it appears, be associated with geomagnetic activity. The evidence so far obtained suggests that ionospheric behavior in the two polar regions is essentially the same. Analysis of these observations may appreciably alter our concepts of the ionization and recombination processes in the atmosphere.

Cosmic rays.—Cosmic rays are electrically charged particles which bombard the earth continuously and from every direction. Although their existence has been known for 50 years, their source and precise nature remain uncertain. In particular, the source of these particles is 1 of the major questions in astrophysics, and the answer is 1 of major importance understanding the cosmos from which the rays take their name These particles, consisting largely of nuclei and having energies ranging from 10^8 to 10^{19} electron volts, are influenced by the earth's magnetic field. Low-energy particles are deflected toward the vicinity of the two geomagnetic poles, and only the more energetic ones penetrate at the middle latitudes.

During the IGY, the scientists of 31 nations are studying cosmic rays at 195 stations; neutron monitors and meson telescopes, cloud and ionization chambers, special photographic emulsions, and window Geiger counters are being used. Rockets and balloons, as well as earth satellites, are important tools for observing these rays. Typical of international cooperation during the IGY is the Swedish-Canadian-American cosmic ray experiment carried out aboard the Swedish merchant ship *M/S Lommaren,* sailing between Sweden and the Union of South Africa.

Investigations at the 20 United States cosmic ray stations have already provided interesting results. The work of scientists from the University of Chicago has shown that the location of the line where the cosmic ray intensity is at a minimum—the cosmic ray equator—deviates systematically from the geomagnetic equator. The experiments leading to this result began in 1954–55 when a neutron pile detector was installed aboard the U. S. S. *Atka,* which conducted a reconnaissance of the Antarctic prior to the establishment of IGY stations in following years. Measurements were made on the trip down to and around Antarctica and back; these measurements were repeated aboard the U. S. S. *Arneb* during the 1955–56 and 1956–57 seasons in Antarctica and were supplemented by aircraft flights in a zigzag pattern around the geographical equator, in October 1956. These studies showed a 40° to 45° westward shift of the inclined cosmic-ray equator with respect to the magnetic equator. J. A. Simpson suggests that this warping may well indicate the presence of important magnetic fields, probably of extraterrestrial origin, which alter the trajectories of the incoming primary cosmic ray particles.

Preliminary balloon flights in and near Minnesota with balloons that carry ionization chambers have shown that, at constant altitude, there is a strong latitude effect. This effect is so strong that changes in latitude of as little as 7 miles can be detected by cosmic ray measurements. Other balloon experiments, at Fort Churchill and Thule, have shown that cosmic rays of lower energy (less than about 2 Bev) have essentially disappeared during the present period of high solar activity, with ionization at high altitudes down to half the value it had in 1954 or 1955.

Perhaps one of the most interesting observations made in the course of IGY cosmic ray experiments was that of relatively soft radiation in the high atmosphere, associated with primary auroral radiations. Rocket and balloon flights have led to the positive identification of the soft radiation: it is X-radiation in the range between 10^4 and 10^6 electron volts. There appears to be good correlation between the presence of such radiation and solar, magnetic, and auroral activity. The effect is probably a secondary one; it is believed that incoming auroral particles create the X-rays by bombardment of atomospheric particles.

Rockets and satellites.—Rockets provide 1 of the 2 important ways of directly measuring phenomena and processes in the upper atomosphere. Rockets are, moreover, unique in that they permit studies of the altitude-dependence of various quantities and events—for example, temperature, pressure, density, and composition. Seven nations are engaged in rocket programs: Australia, Canada, France, Great Britain, Japan, the United States, and the U. S. S. R.

Some 200 rockets are involved in the United States rocket effort. Firings are underway in the Arctic, Antarctic, Pacific, and continental areas. A major facility at Fort Churchill, Manitoba, within the north auroral zone, was constructed in cooperation with Canada, and a joint Canadian-United States program is underway.

There were 29 rockets fired in the pre-IGY test period. These included Aerobees, Rockoons and Nike-Cajuns. Firings took place at the newly erected facilities at Fort Churchill as well as at White Sands (N. Mex.) and Guam, and from shipboard off the California coast and in the North Atlantic These firings were successful, and the preliminary information gained was of considerable value in the final detailed planning of the schedules for firings during the IGY period.

The United States IGY program in rocketry actually began on July 5, 1956, at Wallop's Island, Va., when the first IGY test rocket was fired successfully. To date, 81 rockets have been fired during the IGY. Included have been those in programs conducted at Fort Churchill (9 Aerobees, 5 Nike-Cajuns); White Sands (2 Nike-Cajuns); Point Mugu, San Nicolas Island, Calif. (13 Nike-Deacons), a shipborne operation in the Arctic (18 Rockoons); and a shipborne operation in Pacific and Antarctic waters which was concluded in mid-November (36 Rockoons). The following are some preliminary findings:

(1) A firing at Fort Churchill indicated that the first atmospheric temperature maximum occurred at an altitude of about 60 kilometers. Normally this maximum is found below 50 kilometers at lower latitudes, indicating that, at northern latitudes, the rise is more gradual. (Temperatures decrease up to the stratosphere, rise during the next 20 to 30 kilometers, decrease through the next 30 kilometers, and then rise again.)

(2) A rocket, instrumented for ionospheric studies, was sent through a polar blackout for the first time. Data were obtained which indicated that a very dense D-region exists at a significantly lower altitude, and with a much greater density, than is found at lower latitudes.

(3) A firing at Fort Churchill during the summer of 1957 measured electron distribution in the ionosphere up to an altitude of 250 kilometers during a polar blackout. The results of this experiment confirmed theories that the D-region of the ionosphere is primarily responsible for radio blackouts.

(4) During a series of firings with Aerobees and Nike-Cajuns instrumented for studies of pressure, temperature, and density, it was determined that the distribution of pressure and temperature in the atmosphere at high latitudes is very different from what it is at lower latitudes. Many of these rockets attained altitudes greater than 200 kilometers, and thus the first density measurements made at high latitudes were recorded. Launchings were made during both summer and winter, day and night. The resulting data indicate that the density of the high atmosphere is under strong solar control. There appear to be a latitude effect, a seasonal effect, and a strong diurnal effect; none of these effects appear at lower altitudes at Fort Churchill or lower latitudes.

(5) An experiment with a mass spectrometer at Fort Churchill appears to confirm the belief that diffusive separation of gases under gravity is present above 100 kilometers at that latitude. Below this point the gases in the atmosphere appear to be well mixed.

(6) During July and August 1957, the DAN rocket flare patrol program took place at Point Mugu, Calif. This program was primarily directed toward determining the radiation source of the fadeouts resulting from flares observed on the disk of the sun For the first time, measurements were made of X-ray and ultraviolet bursts from the sun during a solar flare. These data will help in explaining radio blackouts, which are present during periods of unusually high degree of ionization, and which are closely associated with solar flares.

(7) During the shipboard firings in the Arctic, an excellent survey was made for the first time of auroral particles and their association with actual aurorae. Also conducted for the first time at high latitudes were magnetic field measurements.

Satellites represent an extension of rocketry useful in probing the high atmosphere. Satellites provide means to secure data on the variation of phenomena with time and over a vast expanse of space. Two nations are engaged in satel-

lite-launching programs: the U. S. S. R. and the United States. Many nations are cooperating in tracking and ground-based observations. In the United States program, precision radio and optical stations have been established not only in the United States but in 13 other countries whose scientists are cooperating closely with the United States scientists.

The U. S. S. R. launched its first satellite on October 4, 1957. This satellite, a sphere nearly 23 inches in diameter and weighing about 184 pounds carried transmitters broadcasting on frequencies of 20 and 40 megacycles per second.

The second Soviet satellite was launched on November 3. Weighing about 1,120 pounds, the last rocket stage was reported to carry 2 transmitters (20 and 40 megacycles), a dog, and instruments to measure satellite temperatures, ultraviolet light, X-rays, and cosmic rays. The initial period of the second satellite's revolution was 103.7 minutes, with an apogee of approximately 1,056 miles and perigee of about 150 miles.

The United States program is proceeding according to schedule. The Navy has responsibility for the rocket system and launching in the Vanguard series; the Army, for the Jupiter-C series. The IGY Committee of the National Academy of Sciences is responsible for the scientific aspects for both the internal experiments and the radio and optical observation programs. Two types of satellites have been designed: test spheres for use during the test period for the Vanguard rocket system and equipment-laden satellites for use thereafter for both the Vanguard and Jupiter-C vehicles.

The test spheres are 6.4 inches in diameter and weight 4 pounds. They have six 12-inch antennae and 6 solar cells mounted on the skin. These spheres are designed primarily to transmit signals for radio tracking purposes; they carry 2 separate transmitter systems operating on frequencies of approximately 108 megacycles. One is battery-powered while the other is powered by the 6 solar cells, affording the prospect of indefinite transmitter life.

The IGY equipment-laden satellites have 3 main configurations. All but 2 are 20-inch spheres constructed primarily of magnesium, weighing 21.5 pounds, and equipped with four 29-inch antennae. Of the other satellites, 1 is a sphere approximately 13 inches in diameter, with a protruding cylinder approximately 13 inches long and 2.5 inches in diameter; this satellite will be accompanied by an inflatable sphere, 30 inches in diameter and weighing less than 0.7 of a pound, which will be ejected from the carrier rocket at the same time as the satellite is released. The last configuration, a cylinder to be launched in the Army vehicle (Jupiter-C), is of approximately the same weight as the spherical satellites to be launched in the Navy Vanguard rocket.

Equipment carried by these satellites will include instruments to measure the intensity of the solar hydrogen Lyman alpha line; temperatures of the satellite's surface and interior; meteoric erosion, flux, and penetration, geographical, temporal, and altitudinal variations of primary cosmic ray intensity; total magnetic field at altitudes above the more densely ionized regions of the upper atmosphere, air drag; the geographical distribution of the energy received by and radiated from the earth; and the changing patterns of the cloud cover of the earth.

The satellites will be located and data will be obtained from them by means of radio, precision camera, and visual observations, The precision radio tracking system is known as Minitrack; it was developed by and is operated under the supervision of the Naval Research Laboratory. There are 10 Minitrack stations, most of them along the 75th meridian west

The 12 precision optical tracking stations, using Baker-Nunn Schmidt-type cameras, are under the supervision of the Smithsonian Astrophysical Observatory. They are located in 1 longitudinal and 2 latitudinal belts (75th meridian west and 30° to 40° north and south).

There are three programs based on amateur participation in satellite tracking which are designed to supplement precision tracking efforts. The first, for volunteer visual observation teams, is being administered by the Smithsonian Astrophysical Observatory and has been named Moonwatch. Over 100 Moonwatch teams, located both in the United States and abroad, have been registered and are in operation

A similar program, called Moonbeam, has also been established to coordinate the participation of radio amateurs and other volunteer groups having the capability to record telemetry and radio position data. Employing Minitrack II, developed by the Naval Research Laboratory, and Microlock, developed by the Jet Propulsion Laboratory of California Institute of Technology, these volunteer groups supplement the primary Minitrack stations in tracking the satellite and should also provide valuable scientific data.

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The third volunteer tracking program is called Phototrack; it was organized under the supervision of the Society of Photographic Scientists and Engineers. Participants in this program use standard cameras of good quality to photograph the satellite against a fixed background of stars of known positions.

EARTH'S HEAT AND WATER REGIMEN

Meteorology.—Almost all of the energy that the earth receives comes from the sun. This energy evaporates water from the oceans, lakes, and rivers; heats the ground, which in turn heats the air above it; and in general supplies all the energy which drives the winds of the atmosphere.

In the equatorial regions there is more energy received from the sun than is lost back to space; in the polar regions the reverse is true. Since we know that, on the average, considering a year's time, the earth as a whole does not heat up or cool off appreciably, the excess energy gained in the Tropics must be balanced by the loss of energy in the polar regions. The flow of energy between the tropics and the poles is part of the driving force of the atmospheric circulation. A very important factor in the general circulation also is the rotation of the earth. As is well known, the speed at the surface, due to the daily rotation of the earth, is greatest at the equator, which is farthest away from the axis of rotation, and least in the polar regions, becoming zero at the pole itself.

In order to study the winds and circulation of the atmosphere during the IGY, meteorologists of nearly every participating country have intensified their efforts at setting up new stations in hitherto uncovered areas and are making every attempt to send meteorological balloons as high into the atmosphere as possible to measure temperature, humidity, and winds; all countries are collecting meteorological data. In cooperation with the Canadian Weather Bureau, the United States Weather Bureau is operating some key stations in the Far North, supplementing its complex of stations in Alaska and the United States. In cooperation with scientists and weather bureaus of the various South American countries, five new complete weather observatories are now in operation in Chile, Peru, and Ecuador. These five stations are important in a chain of stations reaching from the North Pole, where the U. S. S. R. maintains a station, through Canada, eastern United States, the Caribbean Sea, western South America through Antarctica, and finally to the South Pole, where United States scientists have established a complete scientific observatory.

In addition to this chain of stations, 12 nations have cooperated in locating more than 50 scientific observatories in the vast unknown continent of Antarctica. For the first time, synoptic meteorological charts of this area are being drawn on a daily basis. Weather forecasting has already been markedly improved in the Southern Hemisphere. Aside from the forecasting and synoptic aspect, the scientific value of the observations in Antarctica are potentially of great value in understanding the atmospheric circulation and its relation to solar radiation and topography.

The Antarctic is the coldest place on earth. The continent itself is elevated and mountainous, the South Pole being almost 10,000 feet above sea level. Byrd Station, in the interior, has reported temperatures of about 100° below zero (F.), and recently the South Pole Station reported an even lower temperature, 102.1° below zero.

In the Antarctic meteorology program, large neoprene balloons have been sent to altitudes of over 80,000 feet, and the average is about 60,000 feet. Meteorological balloons sent up at 112 non-Antarctic United States stations are reaching altitudes ranging from 85,000 to 107,000 feet, carrying instruments to radio back to the ground the temperature and humidity.

In addition to these broad-scale programs, several specialized programs are underway, and preliminary results have been received. For example, there is in Little America an instrument which measures the minute quantity of ozone in the air at the ground level. Ozone mainly occurs in a layerlike region about 15 miles high in the earth's atmosphere. Some ozone diffuses to the ground or is formed at lower levels by ultraviolet light. It has been noticed that, at Little America, there is about 25 percent more ozone at the ground than there is in New Mexico. Although ozone is a minor constituent of the atmosphere, it is thought to play an important role in the circulation of the high atmosphere, because of the energy it can absorb and release.

Another minor constituent of the atmosphere which may play a major role in climatic changes is carbon dioxide. This compound is present in the atmosphere in amounts of about 350 parts per million. It absorbs infrared or heat radiation and may act like a trap for such radiation, much as glass does in a greenhouse,

and it may play a very important role in the heat balance of the atmosphere. Our industrial civilization burns tremendous quantities of fossil fuel each year, pouring millions of tons of carbon dioxide into the atmosphere. Most of this is absorbed by plant life and by the waters of the oceans, but there is the possibility that eventually the carbon dioxide content of the atmosphere will rise enough to affect the world's climate. At United States stations and aboard ships, there are seven instruments in use monitoring the content of carbon dioxide in the atmosphere, and scientists are collecting thousands of air samples for later analysis. It has been found already that the concentration of carbon dioxide in the Antarctic is about what it is over the rest of the world away from immediate industrial contamination.

The United States National Committee for the International Geophysical Year was designated by the Comité Spécial de l'Année Géophysique to establish and maintain a Weather Central at the Little America Station to collect and disseminate Southern Hemisphere weather information, particularly for the Antarctic region. The basic program at Weather Central involves the reception and recording of weather data from many contributing sources; preparation and analysis of meteorological charts, maps, graphs, and cross sections—mostly synoptic; and broadcasting of current weather information and analyses for use in forecasting by stations throughout Antarctica and the remainder of the Southern Hemisphere.

The Weather Central staff consists of United States meteorologists together with meteorologists assigned, in turn, by other nations participating in the Antarctic program.

Preliminary reports indicate that significant improvements in the weather forecasts of Southern Hemisphere countries have been made since data from the Antarctic Weather Central became available.

Glaciology.—United State glaciologists are encamped on glaciers and ice fields in Greenland, on the frozen Arctic Ocean, in the mountains of Alaska, on a small glacier in the State of Washington, and on the ice shelves and the great ice sheet of Antarctica, in a broad program designed to map not only the extent of the glaciers and ice but also to understand their flow and their relation to and effect on the local climate. Twenty-seven other countries are also making observations covering all the known ice areas of the world, including glaciers on the equator—at Mount Kilimanjaro and Mount Kenya in eastern Africa.

Technical advances and discoveries have already been made in the two greatest reservoirs of ice in the world, Greenland and Antarctica. In Greenland, scientists of the United States Army's Snow Ice and Permafrost Research Establishment have perfected techniques for drilling deep holes in the ice with hollow drills, much as an oil well is drilled, to obtain a core of ice. The first hole was drilled in Greenland in 1956 and reached a depth of over 1,000 feet. The second hole was successfully drilled in 1957 in Greenland, and a similar operation is now under way in the Antarctic in Marie Byrd Land.

The recent boring in the ice of Greenland reached a depth of 1,438 feet. A complete series of cores 4 inches in diameter were obtained from the first 1,040 feet. Below this depth, recovery of the core is difficult because the release of strains as the ice is drilled causes the ice to shatter. Dissolved gas, which is under great pressure in the ice at these depths, also causes trouble because it bursts through pockets in the ice, increasing the amount of shattering. However, a core was obtained from 1,200 to 1,220 feet, and another from 1,320 to 1,338 feet. These cores are being studied with great care in the laboratory, for they are an invaluable index of climate and precipitation over the past many hundreds of years. Their layers are studied in much the same fashion as tree rings are studied. From the first hole in Greenland, the 1912 layer was identified by the ash from a volcano which erupted in Alaska. The dust from the great explosion in 1883 of the volcano Krakatoa, in the East Indies, will be a help in checking the dating of the annual layers of precipitation in the cores. Because precipitation is lower in the Antarctic than in Greenland, it is expected that this ash layer will be found at a depth of about 150 feet in Greenland and at about 60 feet in the Antarctic.

The great ice sheet of the Antarctic, over 6 million square miles in extent, cannot be studied in anything but a spotty fashion. However, teams of glaciologists, seismologists, and support personnel are traveling by tractors and special over-snow vehicles thousands of miles across the ice in a series of traverses to obtain the profile of ice thickness across the continent and to attempt to learn something of the underlying terrain, or formation of the ice-covered earth. For example, after the Byrd Station was established some 600 miles from Little America by a tractor party, a traverse team then crossed the ice shelf from Little America and continued to Byrd Station, exploring the ice as it went.

The surface ice is examined by taking samples and determining the density, digging shallow pits to learn about the layers of the most recent several seasons, and making measurements of the temperature and heat conductivity of the ice. The deep ice is explored by setting off small explosions on the surface and by listening to echoes reflected by the bottom of the ice and by any deeper layers of the earth's crust. The time the echoes take to return allows calculation of the depth of the ice.

During this first traverse it was discovered that Byrd Station, at an elevation of about 5,000 feet above sea level, stands upon ice almost 10,000 feet thick. Further explorations will reveal whether this is a frozen fjord or inland sea and what part of this submergence may be due to the bending inward of the earth's crust as a result of the weight of the ice.

United States scientists at two locations in the Arctic basin are now making studies of the melting of the ice pack, the freezing of new ice, and the general relations between the state of the ice and the local climate. One of these stations, Drifting Station B, is on an ice island 7 miles by 3 miles in extent and about 140 feet thick. This block of ice was probably calved off the Ellesmere Island ice sheet many hundreds of years ago and has been circulating in the Arctic Ocean since, driven by the winds and ocean currents. This ice island, known as Fletcher's Ice Island, has been occupied previously by United States scientists in studies of the Arctic basin. It is currently at latitude 81°08′ N. and longitude 107°05′ W., about 611.8 miles from the North Pole.

The second station, called Drifting Station A, is now located at latitude 85°30′ N. and longitude 170° W., 310.5 miles from the pole. It is on the ice pack itself, on a floe a few square miles in area and only some 7 to 12 feet thick. Scientists there have noted that, during the past summer season, about 12 inches of ice on the upper surface has melted, while as much as 18 to 24 inches of new ice has frozen on the bottom of the floe. This observation will be placed in proper perspective when all the information on radiation from the sun, ocean currents, and temperatures of the air, ice, and oceans has been studied.

Oceanography.—The oceans, which cover about three-quarters of the earth, are a great storage trap for energy; the oceans are responsible for the fact that the climate of lands near seacoasts is more uniform than that of the interior of continents. Great ocean currents such as the Gulf Stream affect climates in the northern parts of the Atlantic Ocean. For example, Iceland and the British Isles have far less severe winters than they would have were the Gulf Stream not flowing. The surface currents of the oceans are related to the great wind systems, and it has been shown that the Gulf Stream, for example, follows the great clockwise atmospheric circulation in the Atlantic basin. Benjamin Franklin was one of the first to observe the nature of the Gulf Stream; Lt. M. F. Maury, the founder of the United States Navy Hydrographic Office, collected much information from mariners bearing on the set and speed of surface currents in this area, and several years ago an expedition of several ships, Operation Cabot, explored the Gulf Stream in a thorough fashion. It was found that, besides the main stream, there were many small eddies and side currents.

Recently, in a test of instrumentation developed by J. C. Swallow of the National Institute of Oceanography in England, the *Atlantis*, a research vessel of the Woods Hole Oceanographic Institution, and the British research vessel, *Discovery II*, explored the eastern edge of the Gulf Stream and were able to map for the first time the underlying flow of water. They found that, at depths of about 6,500 feet, there was either very little or very erratic movement; shallower depths showed set to the northeast, as expected, but at depths of about 9,000 feet, the current sets southwest at the relatively high speed of 8 miles per day. This new technique, in which the Swallow neutral buoyancy float is used, enables IGY oceanographers the world over to map both surface and relatively deep currents. Thirty-four countries are participating in oceanographic work for the IGY, some with ships and others with coastal and island observatories.

The deeper currents of the oceans have proved difficult to observe. Cold water is formed in the polar regions from melting ice; this water, being dense, sinks, displacing lighter water which then flows away from the polar regions toward the equatorial regions. Bottom topography such as ridges, canyons, and mountain ranges influences the flow of bottom waters, and it is possible that some bottom waters become trapped in basins It is not known whether bottom water makes a circuit from pole to equator and back in tens, hundreds, or thousands of years. The bottom waters play an important role in man's economy, for the extent to which the seas can support life is dependent upon the food supply in the water The bottom waters are rich in chemical nutrients, and, wherever these

waters upwell, there are found the great fishing banks, such as the Grand Banks off Newfoundland and the Peruvian fishing grounds.

Several United States ships have already made extensive cruises for the IGY. The work of the *Atlantis* has already been mentioned. The *Crawford*, also of the Woods Hole Oceanographic Institution, made a 4 months' cruise in the Atlantic. The *Crawford*, reoccupied many stations taken years ago by the German ship *Meteor* and discovered that there have been pronounced changes in the amount of oxygen dissolved in the Atlantic in the region of 15° south latitude. The difference in oxygen content over the past 30 years may mean that deep bottom water is not being formed as fast now as it was previously, but further data and analysis are needed for proper interpretation of the present observations.

The *Vema*, a research vessel operated by the Lamont Geological Observatory of Columbia University, has completed an extensive cruise in the South Atlantic Ocean, working along the coasts of South America and Africa, and crossing the Atlantic at high southern latitudes between Argentina and Capetown. The *Vema* cooperated with the *Bahia Blanca*, a survey vessel of Argentina, in making explorations of the submarine crust by seismic methods. Considerable marine biological work was also done, and Lamont has reported that living organisms—a small shellfish and a worm one-fourth of an inch long—were recovered alive from depths of 13,200 and 16,200 feet, respectively. Lamont scientists believe these to be record depths for retrievement of live marine samples. The *Vema* left New York in November for a 10-month trip to the Atlantic and Indian Oceans as the second phase of Lamont's oceanographic work for the IGY.

In the Pacific, the *Brown Bear* of the University of Washington worked in the Northeast Pacific Ocean last summer. The deep currents in that area were studied. The *Horizon* and *Baird*, research vessels operated by the Scripps Institution of Oceanography of the University of California, left San Diego in October for a 2-ship, 5-month expedition through the Central and Southeast Pacific. They will call at Tahiti (Samoa), Easter Island, Valparaiso (Chile), and Callao (Peru) and make seismic explorations of the submarine crust, study surface and deep currents, take bottom samples, and occupy about 40 oceanographic stations, where water samples down to great depths will be obtained for later analysis of chemical content. The *Jakkula*, of the Agricultural and Mechanical College of Texas, will cruise in the Caribbean Sea and western Atlantic in the summer of 1958.

Another part of the IGY oceanography program is the study of the mean sea level over the period of the IGY. It has been found from study of tide data that there seems to be an exchange of water between the Northern and Southern Hemispheres as the seasons change. Some of the change in mean sea level between summer and winter has to do with the expansion and contraction of water with temperature. New tide gages are being set up to supplement the existing network: Instruments are already operating in Bermuda, Iceland, and the Azores, in the Atlantic, and in the Caroline and Marshall Islands and, with the cooperation of French scientists, at French islands in the southeast Pacific. A station is in operation on Pitcairn Island under the supervision of a descendant of one of the mutineers of His Majesty's ship *Bounty*. At least 200 tide gage stations are being operated in the worldwide program, 32 of them by the United States.

In the Arctic Basin, United States oceanographers pursue their science from camps on the frozen ocean. The track of one of the stations has carried observers over what appears to be a newly discovered ridge, or underwater mountain chain. Scientists of the Soviet Union are doing similar work at two stations in the Arctic Basin.

In the Antarctic the ships of the various nations supporting scientific stations on the continent engage in oceanographic observations en route to and from the area. Thus, U. S. S. R. and New Zealand ships have added to our knowledge of these waters. Ships of United States Navy Task Force 43 are also exploring the coast, charting the bottom, and taking bottom and water samples for future study.

EARTH'S STRUCTURE AND INTERIOR

Seismology.—During the IGY, seismologists of 50 nations are obtaining earthquake information from almost all regions of the world, particularly in those regions not hitherto covered, as, for example, the Antarctic Continent. In addition, several new types of seismographs with wide range and high sensitivity have been located at observatories throughout the world. The Lamont Geological Observatory has constructed 10 special, long-period seismographs and has installed most of them at observatories ranging from Hawaii to Fiji and from Bermuda to the Antarctic. These long-period instruments are sensitive to surface waves with periods of about 400 seconds, generated only by the very largest

earthquakes. These wavelengths are so long that they penetrate to the interior of the earth, and, in fact, the whole earth itself may be set into vibration. Recently workers at Lamont have discovered the existence of certain intermediate waves with periods of about 100 seconds. These waves, which were previously only known in the crust in continental structures, have been identified now in the mantle, or the next layer beneath the crust. These waves permit better resolution of structural details than the longer 400-second waves, and study of their propagation is expected to provide new information on the distribution of materials in the interior of the earth.

Seismologists from the Department of Terrestrial Magnetism of the Carnegie Institution of Washington worked on exploration of the roots of the Andes Mountains in South America last summer and fall. They have found roots of unsuspected depths and are now working on their data to obtain better understanding of the crustal structure under this great mountain chain.

Seismologists of the United States Coast and Geodetic Survey have installed new seismic equipment in the Pacific at Truk and Koror and have been obtaining records of Pacific earthquakes. These new stations, together with those in the Antarctic, will add significantly to our knowledge of seismicity and the structure of the earth.

Gravity.—The earth is the attracting mass for all bodies on the earth. The earth, however, is not a perfect sphere, nor is its mass uniformly distributed. Furthermore, it is rotating. These conditions add up to the fact that gravity is not uniform and constant all over the earth. In general, because of the fact that the earth bulges somewhat at the equator and centrifugal force is greatest there, gravity is least at the equator and increases toward the poles. This effect is large enough to make a 200-pound man weigh 1 pound more at the pole than at the equator. In addition to this nonuniformity, great continental mountain masses, underground ore bodies, undersea mountains, and, in general, the uneven distribution of mass around the crust of the earth, contribute to local anomalies, some of which may be sufficiently large to deflect a plumb bob away from the vertical. Although this deflection is less than 10 seconds of arc, there are a few locations—Puerto Rico is one—where it exceeds 1 minute. This effect is significant in geodesy wherever geodetic control depends on astronomical observations.

The IGY program in gravity is aimed at increasing the reliability of measurements of gravity over the world, particularly in providing very accurate and reliable measurements at certain key locations to provide connection points between the gravity networks of various countries. Many measurements have been made already, including observations in the Arctic basin taken from United States IGY stations on the drifting ice. An important new station is located in Antarctica, where first-order measurements of gravity were made to provide a calibration for future measurements in the interior.

The first successful surface measurements of gravity on the open sea were made on November 22, 1957, by J. Lamar Worzel of the Lamont Geological Observatory, who used a sea gravimeter developed by Anton Graf of Munich. In the past, gravity measurements for oceanic areas required measurements aboard submarines at quiet depths below the surface. The difficulty of obtaining and fitting submarines for this purpose made it impossible adequately to survey the seas: only about 4,000 such measurements have been made throughout the world. The new instrument, mounted on a gyrostabilized platform, will make it possible to obtain data simply and quickly anywhere at sea with a precision of one part per million, similar to that attainable on land.

As the moon rotates around the earth and the earth rotates around the sun, the solid earth undergoes the same kind of tidal bulging that occurs in the oceans, although, of course, by a much lesser amount. Yet, it is enough to be observed with the most sensitive gravimeters. As the earth heaves in tidal motion, the distance of a point on the surface from the center of the earth changes by a small amount, perhaps a few tenths of an inch to several inches. This can be detected directly by instruments which are now in use recording the "pulse" of the earth, instruments which are sensitive to one part in one billion of the average value of gravity.

Latitudes and longitudes.—Scientists of 29 countries at 45 IGY stations around the world are in the process of determining longitudes and latitudes more precisely. Besides making transit observations at 3 stations, the United States is furnishing 21 of the moon position cameras developed at the Naval Observatory for use at stations in the United States and throughout the world; the first camera is now in operation at the United States Naval Observatory in Washington, D. C. When used in conjunction with the Danjon impersonal astrolabe, this instrument will permit more precise location of the earth's land masses than was hitherto possible.

IGY DATA

The preceding sections suggest the nature of the IGY activities as shown by the United States IGY effort in the first few months of the program. With 67 nations cooperating in the endeavor and some 10,000 scientists and technicians making observations and measurements at more than 2,000 stations, the volume of data stemming from the program will be considerable. To insure the safety of the raw data and their accessibility, the international IGY committee has approved the establishment of three world data centers.

World Data Center A is located in the United States and has 11 subcenters: visual auroral observations (Cornell University); instrumental auroral observations (University of Alaska); airglow and ionospheric physics (National Bureau of Standards, Central Radio Propagation Laboratory); cosmic rays (University of Minnesota); geomagnetism, gravity, and seismology (U. S. Coast and Geodetic Survey); glaciology (American Geographical Society); latitude and longitude (U. S. Naval Observatory); meteorology (U. S. Weather Bureau, National Weather Records Center); oceanography (Agriculture and Mechanical College of Texas); solar activity (University of Colorado, High Altitude Observatory); and rockets and satellites (National Academy of Sciences).

World Data Center B, operated by the U. S. S. R., has two subcenters. The first, at Novosibirsk, includes meteorology, geomagnetism, longitude and latitude, glaciology, oceanography, seismology, and gravity. The second, at Mocsow, includes aurora and airglow, ionospheric physics, solar activity, and cosmic rays.

World Data Center C, operated by several nations in Western Europe and the Pacific, has the following subcenters: geomagnetism (Denmark and Japan), aurora (Sweden and Great Britain), airglow (France and Japan), ionosphere (Great Britain and Japan), solar activity (Switzerland, Italy, Great Britain France, German Federal Republic, and Australia), cosmic ray (Sweden and Japan), glaciology (Great Britain), meteorology (World Meteorological Organization, Geneva), and seismology (International Central Seismological Bureau, Strassburg).

Each data center will acquire a complete set of all IGY data. Each center will archive and index its compilation of data, holding it accessible to research workers. Schedules for the orderly flow of data into the centers have been arranged. These schedules vary, depending upon the nature of the data in a given discipline and upon the definition of a reasonable "lot" of data to simplify the handling problems. A "lot" of data may be 1 month's observations in one field or several months' observations in another.

The procedures in handling data and forwarding them appropriately involve a series of steps of the following kind: (*i*) Collection of a "lot" of data at a field station, (*ii*) transmittal of the "lot" to the home laboratory of the field station, (*iii*) checking of field data at the home laboratory, (*iv*) transmittal to one of the world data centers, (*v*) copying of the data by one world data center for the other two and appropriate transmittal, and (*vi*) indexing and archiving at world data centers.

The data centers are in operation, and data are flowing into the centers. The steps outlined above lead to a peak early in 1958 and a steady 18-month plateau through at least the first 6 months of 1959, followed by a clean-up period extending probably into the first quarter or so of 1960 (1).

NOTE

1. The preparation of this narrative would not have been possible without the cooperation of many scientists and institutions engaged in the IGY program. Although some of them are mentioned in the text, it has not been possible in this summary to refer to all. The United States States IGY program has only been possible because so many individual scientists as well as public and private institutions have participated and cooperated in the endeavor. Particular acknowledgment is made to members of the National Academy of Sciences' IGY staff who have helped in the preparation of this report: Stanley Ruttenberg, Phillip Mange, John Hanessian, Jr., and John Truesdale.

Mr. FULTON. As a matter of fact, I was going to ask your agency to prepare a short summary of the results of the Vanguard and Explorer programs that are going to be explained on Thursday.

Dr. WATERMAN. Good.

Mr. FULTON. Next I would like to have the documents put in the record, or excerpts or summaries of them, showing that you have

been assigned through your agency to participate in the International Geophysical Year or, if there is correspondence, as to methods of setting them up. Your relationship should be explained, if you will, with the other agencies in the United States that are likewise participating so that we can have an overall view of what the United States has been doing in the IGY.

Dr. WATERMAN. Good.

Mr. FULTON. Again, if it is not too much, I would likewise appreciate your submitting a short history of the start of the IGY, how it happened to build up, and possibly an account of the conference in Barcelona, Spain.

Dr. WATERMAN. You mean the international planning or our own plans in it, or both?

Mr. FULTON. I would like to know generally, have it collected and collated in one spot, and show how these plans developed, for the benefit of the layman rather than have the information appear in all the scientific journals where the average person does not have a chance to get an overall view.

While we are talking about outer space, the question comes up, of course, as to its use. Now, we can either use outer space in the United States alone for our own purposes, or in conjunction with other people. Would you recommend that the United States have a United States policy for outer space to be implemented by a national space agency, both for civilian and military purposes?

That is, the policy rather than the implementation.

Dr. WATERMAN. The policy of the Agency is rather clear, if I understand you correctly. It is designed to study aeronautics and space exploration and the means to do this. So the policy is one of exploring space and to do the research necessary to make those explorations.

Mr. FULTON. So that the Columbus of 1958, 1959, or 1960, will be started on his exploration by the national space agency both as to planning, research and development and implementation with hardware?

Dr. WATERMAN. Right.

Now, the military have their own side of this which is important of course. So they similarly have a mission which, without going into any detail, would be to conduct the necessary research and development to provide for vehicles which can accomplish military missions in space.

Mr. FULTON. At what level do you think these satellites that circle the earth are dangerous to our United States security? Is it 50 miles, 60 miles, 100 miles, or 200 miles?

Dr. WATERMAN. That gets into a technical question as to the manner in which they could be a danger to our security.

I believe there has been fairly good evidence that a satellite as such is not a danger to the national security in the sense that most people think it is. It is not dangerous like an airplane because it cannot drop anything for the reason we just talked about, or if it could, it would be a very clumsy way. It would be a clumsy way to try to hit the target because the complications of getting it down to where you want it would be so very severe.

It should not be thought of then like an airplane traveling overhead or anything of that kind. It physically can do very little to endanger the national security.

Mr. FULTON. When you get out to the reaches of 150 miles at the perigee of an orbit, there is no particular military danger to the United States because the facilities are not present to use it to meet military capabilities, or rather there is not the proper weaponry.

Dr. WATERMAN. I cannot quote an authority on this because it is not my area.

It seems to me as a military weapon the satellite cannot be regarded in the same kind of class of weapons as we have.

Mr. FULTON. If we use ion propulsion which can provide continuous thrust that can accelerate a vehicle which is launched in outer space up to some portion of the speed of light, it is not too far beyond the realm of probability that we could aim a vehicle at approximately the nearest star and actually reach it.

Dr. WATERMAN. That is true.

Mr. FULTON. So when we are talking of the solar system, it should not be taken that these distances are completely beyond us because they are not within our realm of practical comprehension now. We should keep our minds open?

Dr. WATERMAN. Yes.

I was thinking when I said this, of course, about the travel of people, because then it gets pretty complicated when you have these long times. It is another thing if you talk about travel of scientific instrumentation which is the best way to start an exploration.

To make trips of exploration with scientific instruments which can be made uncanny in what they can perceive and tell us about, is certainly the logical thing to do and their time does not give the same complication.

Mr. FULTON. Because this is a new idea committee and yours is one of the new idea departments of government or agency, has any thought been given to the starting of space platforms not from the earth?

For example, all the smaller planets that have been discovered from time to time in addition to the larger ones are simply small masses floating in space. If we have that amount of material already up in outer space and have a space vehicle within the planetary system, all we need to do maybe is go out and assemble these things that are almost weightless in an orbit.

For example, if you could get 150,000 pounds of material about 25,000 miles out in space, it would weigh 1½ to 2 pounds. So the problem would be to go around and get these things, gather them together, bring them in and move them about the earth. You do not have to talk about tremendous rockets; is that right?

Dr. WATERMAN. It is conceivable. It will be a long time before we might be in a position to do it, but this is certainly conceivable enough.

Then we could begin to cultivate the idea of space platforms not just going around like a satellite around the earth, but one that goes around wherever it feels like, with rocket propulsion of some kind, some kind of propulsion whose power supply is always available.

If that were done, then, of course, one would not talk about a space platform just going around the earth, but wandering around as it felt like.

Mr. FULTON. So with the material out in these small planets we might sometimes be working them and transforming them in outer

space rather than all this talk of getting the tremendous weights out from the earth's atmosphere.

Dr. WATERMAN. That is something we can keep in mind as we progress to further knowledge.

Mr. FULTON. At Edwards Air Force Base during April there was a rocket that carried 26,000 pounds just a few weeks ago.

Now, that is the weight of a large loaded freight car. Hence, we in the United States are moving in a direction where accelerating or moving these heavier weights into outer space comes within practical view, do they not?

Dr. WATERMAN. They do, with respect to overall weight. If you have to start them moving they still have the same amount of mass. That is to say, they have a great amount of inertia.

Mr. FULTON. But for a rocket to take up 26,000 pounds through one vehicle, is quite a heavy load to be moving.

Dr. WATERMAN. Yes.

Mr. FULTON. It is the equivalent of taking a loaded freight car in the air from a dead start?

Dr. WATERMAN. That is right. I do think that the important thing as we said before, is to look at this from the standpoint of how far can we get in the exploration of space and the study of the space around the earth. We should first do this by instruments and then move systematically and intelligently into the next phase and not get to talking too much ahead of time but take the steps logically in order as we find them feasible.

This is the economical way to do it and the only wise thing to do, to take them normally and intelligently and learn about them before taking the next step.

Mr. FULTON. You would study the photon propulsion, ion propulsion, solar energy propulsion as practical basic studies?

Dr. WATERMAN. Yes, indeed.

Mr. FULTON. And do these along at the same time as we do the other programs?

Dr. WATERMAN. Yes.

Mr. FULTON. We talked of the question of the poles of magnetic fields. When there is a pole in the magnetic field it actually gives off an ion emission. A pole in a magnetic field will give off an ion emission at the point of it?

Dr. WATERMAN. No, sir. The magnetic field as such does not have particles in the ordinary sense. It just has a magnetic force. The pole is just a center where the force converges or diverges from, but there are no particles involved like electrons or things of that kind.

Mr. FULTON. But there is a force there that could make, by proper use, some return?

Dr. WATERMAN. It could have an effect on other particles if they had magnetic properties.

Mr. FULTON. Maybe that is a better way to say it. So by an electronic effect on particles, if properly used, we might be able, from magnetic poles, to develop a force possibly in the earth's magnetic field. We might be developing a force that we do not know about? Is that not possible?

Dr. WATERMAN. It does not seem possible to me as I understand your point. You see, the magnetic field of the earth is a very small thing. As magnetic fields go, it is a very weak field indeed.

It does not take any great strength to keep the compass from pointing north. The space outside is even less than that. So it is a rather weak force.

What is conceivably possible is to generate electricity by using the speed with which these bodies go through the earth's magnetic field. That is just the principle of the dynamo.

You could perhaps generate electricity in some such way. That is rather farfetched, I would think.

Mr. FULTON. There is something I would like to refer you to, Then I will be through. That is the effect on the electronic characteristics of the world, the earth, through the action of these cosmic rays. We have not yet found out enough about them to see what electronic effect they do have.

For example, the Germans, originally, and the Japanese have been investigating these electronic variations on the earth's surface, and, in particular, the electronic pole that is around Washington here.

Would it be effective for you to study the electronic systems of the earth through the investigations in outer space, which would help us develop electronic instruments?

Mr. NATCHER. Will the gentleman yield?

(Discussion off the record.)

Mr. BROOKS (presiding). Mr. Ford.

Mr. FORD. This is the question I would like to ask and I do not think it is entirely clear for the record.

What is the distinct difference between the National Science Foundation and the National Academy of Science?

Dr. WATERMAN. There are several. In the first place, the National Science Foundation is an independent Government agency which receives its funds from Congress.

The National Academy, on the other hand, receives no funds from Congress but is outside the Government in the sense that it has its own autonomous existence, it elects it members and so on.

It operates largely by means of the National Research Council associated with it to perform studies for the Government agencies, for the Government and for other groups anywhere in the country, such as studies on scientific questions.

Where one wants a study made, it may advise the Government. In that case it may receive its funds for the cost of the study from the Government agency. It does not get funds directly from Congress in that sense.

The National Academy of Sciences is certainly the highest authority of science in the country and the most distinguished body of science in the country.

Mr. FORD. Is it chartered by the Federal Government?

Dr. WATERMAN. It is chartered by the Federal Government with these terms I pointed out. Sometimes it is called a quasi-Government agency because it has a charter from the Federal Government.

The CHAIRMAN. If there are no further questions at this time, we will adjourn. The committee will stand adjourned until tomorrow morning at 9:30.

(Whereupon, at 4:20 p. m., the committee recessed, to reconvene at 9:30 a. m., Wednesday, April 30, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

WEDNESDAY, APRIL 30, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS
AND SPACE EXPLORATION,
Washington, D. C.

The committee met at 9:30 a. m. in the Caucus Room, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack (chairman), Brooks, Hays, O'Brien, Natcher, Sisk, McDonough, Fulton, Keating, and Ford.

Present also: George J. Feldman, director and chief counsel.

The CHAIRMAN. The committee will be in order.

Dr. Waterman, I understand they had not completed questioning you yesterday.

STATEMENT OF DR. ALAN T. WATERMAN, DIRECTOR, NATIONAL SCIENCE FOUNDATION, ACCOMPANIED BY JAMES M. MITCHELL, ASSOCIATE DIRECTOR, AND WILLIAM HOFF, GENERAL COUNSEL

Dr. WATERMAN. Yes, sir.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. You were speaking of the magnetic influences on the earth and we were talking about the magnetic poles.

I have a question about what research has been done on the Vanguard and Explorer vehicles on magnetic plots.

Dr. WATERMAN. As far as I am aware, the satellites that have been taken up to date have made no magnetic observations.

Mr. FULTON. But you do have plans?

Dr. WATERMAN. Yes.

Mr. FULTON. Are you at liberty to say what kind of plans you have on the investigation of magnetic flux with respect to the earth?

Dr. WATERMAN. The experiment which has been designed for the purpose is one which measures the strength of the earth's magnetic field at points where the satellite is traveling and also records, therefore, any changes in the strength of the earth's magnetic field there.

Mr. FULTON. That will have a direct effect, will it not, on radio waves, electronic instruments and things that we refer to as static?

Dr. WATERMAN. Yes. This is part of the whole phenomenon. Any time there are electrified particles coming from the sun, for example, they have an effect on the earth's magnetic field and they have an effect on the ionosphere. Those are associated in affecting radio communication.

Mr. FULTON. For any system that we might perfect of worldwide television using vehicles or satellites as stations, we would have to know more about the various electrified particles and magnetic flux, the poles and things of that sort?

Dr. WATERMAN. That is correct.

Mr. FULTON. Thank you. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Dr. Waterman, what is your definition of space science?

Dr. WATERMAN. There is no official definition made by science, as far as I know.

Mr. FELDMAN. What is your definition of space?

Dr. WATERMAN. Space is one concept which the sciences over the years have had trouble in defining rather precisely. This recalls an article in the early days after the publication of the Einstein theory and attempts to explain it when a physicist offered to explain it in words of one syllable, and he defined space as "Where we are and where we ain't."

Really I suppose a physicist would define it something like this. We can observe matter, substance, so that space is where we actually do or may expect to observe matter, or radiation from matter. But, of course, it is a very broad term. In this context obviously it means the region outside the earth's atmosphere.

Mr. FELDMAN. I would like to refer you to line 7 of page 2, section 2 of H. R. 11881, which is the administration's bill introduced by the chairman of this committee. It reads:

> Except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense.

On April 2, 1958, there was a memorandum for the Secretary of Defense and chairman of the National Advisory Committee for Aeronautics, signed by the President.

In paragraph 3 it says:

> The ultimate potential of space cannot now be fully grasped. Since some of these potentialities clearly have significance from the standpoint of our national security the Department of Defense will have the continuing interest in the programs to be undertaken and will continue to sponsor programs which may be peculiar to, or primarily associated with, military weapons systems and military operations as well as research and development which may be of a general supporting character.
>
> Furthermore, I desire that the skills and experiences that have been developed within the Department of Defense be fully utilized in supporting civil space programs. However, it is appropriate that a civilian agency of the Government should take the lead in these activities related to space which extend beyond the responsibilities customarily considered to be those of the military organization.

Now, we know that a lot of space research, a lot of development in connection with space satellites and so on, have both military and civilian significance.

Under the language which I just read, how would you determine what is customarily considered to be those of a military organization or primarily associated with weapons systems of military operations? How could that be determined?

Dr. WATERMAN. The clearest way, I believe, would be to have the Department of Defense state what in their opinion constitute mili-

tary research and travel in outer space and be able to justify before the administration that this was appropriate to their mission.

There are certain things which they already have, of necessity, found that they will have to do, such as the travel of ballistic missiles through outer space.

On the other hand, the new space agency, the NASA, would similarly outline their aims and these excursions for all sorts of purposes in outer space would be very much broader and the kind of observations they would make would form a much broader program than the Defense program itself.

So the clearest way is to ask each agency to state what its objectives are and what it seeks to do and be able to justify it before the Administration and then budgetwise before the Congress.

Mr. FELDMAN. Before you get a program underway it might take a long time, is that not so?

Dr. WATERMAN. I hardly think so, sir, because before an agency can have funds it must justify its program. I think this would occur naturally in the budget procedure. That would be my opinion, at least.

Mr. FELDMAN. There seems to be, at least in my mind, a striking difference between the directives and the wording of the proposed legislation. One seems to emphasize the fact that the military could take to itself anything of a military character. This might include about everything in the space vehicle category, because they are just as concerned with weather and communications and related things, even cosmic ray studies and matters of that sort, as the nonmilitary is.

Dr. WATERMAN. There are degrees of interest there, I believe. It is true, of course, that the military are concerned with weather, but so is the civilian population. As to the interest in terms of volume and quantity, certainly the civilian interest is overriding there. It seems to me that one could keep the same kind of distinction there is now between the Weather Bureau operations and other research in meteorology and what the services have an interest in, so that the observations made by the vehicles of this agency that are concerned with weather would be available to the Department of Defense. Then they could take that and build into it any special research which they felt was of particular military importance. This would also be a cooperative thing, but the civilian interest would be broader; that is my point.

Mr. FELDMAN. You do not feel there will be any difficulty?

Dr. WATERMAN. I should think not. On most subjects this could be handled the way it has been before, like meteorology, for example. There would be new subjects where it might be necessary to have some decision made as to relative responsibilities, but most would have to be cooperative in many ways.

Mr. FELDMAN. I refer you now to section 6 (a) (1) of the proposed legislation beginning with line 18 on page 5. It reads:

> The Agency shall develop a comprehensive program of research in the aeronautical space science.

As distinguished from the next section, which reads:

> The Agency shall plan, direct, and conduct scientific studies and investigations of the problems of manned and unmanned flight within or outside the earth's atmosphere with a view to their practical solution.

Does not your organization have a great deal to do with the space sciences?

Dr. WATERMAN. Our function, of course, is to deal with basic research wherever it may be found, including outer space and astronomy and the problems of basic research with respect to the earth, geophysics, and all the rest of it.

So we are on the very basic side of this program and, therefore, have an interest in such matters as the question of what is meant by "space science" in section 6 (a) (1) which reads "develop a comprehensive program of research in the aeronautical and space sciences."

I consider, Mr. Chairman and gentlemen, as the major aim of this Agency the science of space exploration. The reason for establishing it is because it is a hard, difficult, complicated task to proceed with the whole art and science of providing means of getting objects into space beyond the earth's atmosphere, whether they are going to go into orbit, or whether they are going to travel out further.

This is a very difficult undertaking and it is essentially practical in nature. So that the core of the research they do should be directed toward solving the problems which they are going to encounter. These are quite severe and need very concentrated attention.

So, one might say, as specifically and practically stated in section 6 (2):

> Plan, direct, and conduct scientific studies, investigations of problems of manned and unmanned flight within or outside the earth's atmosphere with a view to their practical solution.

This is the main core of the Agency's mission.

Section 6 (a) (1) is intended to give the Agency some latitude to do research which provides a better understanding of these problems, but which is not specifically and directly designed to make a better rocket or better guidance or something like that.

I should say I do not know exactly what one means by space sciences. One could state, "Develop a comprehensive program of research in the aeronautical sciences and space flight," which I think might provide that degree of generality which might be needed without defining what is meant by space science.

Space science would be subject to a large number of interpretations.

Mr. FELDMAN. It might conflict with what you are doing; is that not so?

Dr. WATERMAN. I do not really think we have a conflict, because we are both interested in the same thing, though we have different responsibilities.

In the Science Foundation we would be very much interested in providing observations in pure research rather than the ones which bear on the problems of flight. They would be interested in this as well because of the effect it would have on their programs.

I believe that they would turn to us because we have a staff and experience in the pure sciences, for cooperation here, as outlined on the next page, I think it is.

Mr. FELDMAN. Let us get down to on the next page, line 3:

> Arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations and provide as appropriate for dissemination of data collected.

Do you not think that that should be clarified by some amendment which will tie it in with your organization?

Do you have any thought about some language that could be used there?

Dr. WATERMAN. As I state in my testimony, we would expect to cooperate in accordance with our interests. It could be stated that if the Government's interest in planning scientific measurements of the pure research variety should be given special recognition, the section could state "in cooperation (or in collaboration or in consultation) with the National Science Foundation arrange for participation by the scientific community," or words to that effect.

The CHAIRMAN. Would not that take away what you testified to yesterday, that the space agency would be more or less an organization for outer space?

Dr. WATERMAN. It would, in solving problems on how to deal with travel in outer space and to explore possibilities of that travel.

The CHAIRMAN. Of course, we have these complications. I do not blame you and the others for protecting the Foundation. I am a great supporter of foundations.

But we are going to have a new agency. We want to know what the jurisdiction is. The executive should be very frank with the committee in stating the objectives so that we know what the objectives are.

Before we establish an agency, we certainly want to eliminate as much duplication as possible. There is bound to be a twilight zone, I recognize that.

Dr. WATERMAN. I do not know of any that would quarrel with the provisions of 6 (4) on page 6. So the question I was asked by counsel is whether there should be an explicit statement of the function of the Foundation here.

If the committee feels this is desirable it could be stated "in consultation (or in cooperation) with the National Science Foundation." The National Academy of Sciences, of course, is another organization which might well be consulted here.

As I stated yesterday, I believe we would have full cooperation here because an agency is not likely to turn into areas that require a completely new staff for the purpose if it can find that another agency can furnish that kind of advice.

Mr. FELDMAN. I have no further questions.

The CHAIRMAN. Thank you very much, Dr. Waterman. For myself, as chairman, and other members of the committee, I thank you and the other gentlemen.

Dr. WATERMAN. Thank you, Mr. Chairman.

The CHAIRMAN. We would like to have you look over the bill and if you have any suggestions, particularly how it could be strengthened, we shall be very glad to hear from you.

Also the declaration of purpose, that has some importance.

Mr. FULTON. Would you put in the record, please, a statement of your relationships with other countries as well as anything that might have been done with the visit of the Russians to this country during the international geophysical year and what access they might have had to our information of a scientific nature?

Dr. WATERMAN. Yes, sir.

(The question asked above is answered below:)

MATERIAL FOR THE RECORD IN RESPONSE TO QUESTIONS OF CONGRESSMAN FULTON (VARIOUS PAGES), HOUSE SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION

I. HISTORICAL BACKGROUND AND INTERNATIONAL ORGANIZATION OF THE IGY

The period July 1, 1957, through December 31, 1958, has been designated as the International Geophysical Year. It is a period of worldwide observations and studies of the sun, and of the earth and its physical environment, including its atmosphere and the space through which it travels. Sixty-six nations are taking an active part in the program.

The IGY is actually the third such scientific undertaking. During 1882–83, the first polar year, 10 nations, including the United States, conducted simultaneous cooperative scientific observations in the Arctic. Fifty years later the second polar year, 1932–33, was undertaken, in which 30 nations cooperated in observations primarily in the Arctic. Both of these periods contributed greatly to the store of basic knowledge in the geophysical sciences.

In April 1950 at an informal meeting of geophysicists in this country the suggestion was offered that, because of the tremendous advances in instrumentation that had taken place in the 1940's, consideration be given to holding a third polar year 25 years after the second, which would place it in 1957–58, a period of maximum sunspot activity. The suggestion was received with enthusiasm, and in subsequent discussions scientists throughout the world recognized the benefits of extending the planned program to encompass the entire earth and renamed it the International Geophysical Year to reflect the increased scope in coverage.

During the next 18 months the initial proposal was considered and supported by a number of international scientific groups, most of them members of the International Council of Scientific Unions (ICSU). The Mixed Commission on the Ionosphere endorsed it as did, also, in rapid succession, the International Scientific Radio Union, the International Astronomical Union, the International Union of Geodesy and Geophysics, and finally the International Council of Scientific Unions itself.

In 1951 the Executive Board of ICSU appointed the Comité Spécial de l'Année Géophysique Internationale (CSAGI), composed of representatives of the various scientific unions involved and of the World Meteorological Organization and the International Consultative Committee for Radio Communications. A Bureau of CSAGI was appointed consisting of Prof. Sydney Chapman (Great Britain), president; Dr. Lloyd V. Berkner (United States), vice president; and Prof. M. Nicholet (Belgium), general secretary. Later (in June 1957) Prof. V. V. Beloussov (U. S. S. R.) and Prof. J. Coulomb (France) were added as members of the Bureau.

In late 1951 and early 1952 CSAGI invited member nations of ICSU to establish special national committees to take part in the planning and guidance of the IGY. As the concept of the IGY expanded, invitations to all countries of the world were issued to join in the enterprise.

A coordinated worldwide scientific program for the IGY was synthesized from various proposals submitted by individual nations and modified through periodic meetings of CSAGI (Brussels, 1953; Rome, 1954; Brussels, 1955; and Barcelona, 1956). A fifth meeting of CSAGI is scheduled to be held in Moscow in August of this year.

II. UNITED STATES PARTICIPATION IN THE INTERNATIONAL GEOPHYSICAL YEAR

United States National Committee for the IGY

The National Academy of Sciences-National Research Council, a nongovernmental organization, as the adhering body on behalf of American scientists to the International Council of Scientific Unions and most of its Unions, was the group in the United States that received the CSAGI invitation for this country to participate in the IGY. In response to this invitation, the Academy-Council established in February 1953 the United States National Committee for the International Geophysical Year 1957–58, under the chairmanship of Dr. Joseph Kaplan, professor of physics at the University of California at Los Angeles. Dr. Alan H. Shapley of the National Bureau of Standards was named vice chairman, and Mr. Hugh Odishaw, formerly of the National Bureau of Standards, the

executive director. The committee membership included appropriate representation from the various scientific disciplines involved; subcommittees were named to cover the regional programs planned (Arctic, Antarctic, equatorial regions); and 13 technical panels were established to direct the program in the scientific disciplines of meteorology, geomagnetism, aurora and airglow, ionosphere, solar activity, cosmic rays, longitude and latitude, glaciology, oceanography, seismology, gravity, and in the programs of rocketry and communications.

Role of the National Science Foundation in the IGY

The Academy-Council recognized the importance of Government cooperation and support to the success of the United States portion of the IGY program. On November 25, 1953, the Academy-Council transmitted to the National Science Foundation the recommendation of the United States National Committee for the IGY that the Foundation be asked to take responsibiliy for obtaining and administering Government funds required to carry out the program and to coordinate the interests of Government agencies involved (attachment A).

After consideration of the recommendation and a study of the proposed program and budget, the National Science Board at its meeting of January 29, 1954, endorsed the program and the Foundation's participation in it. With the endorsement of the administration, the Foundation proceeded with the implementation of United States plans, including the coordination of Government interests in the program.

After submission of the proposed budget and program for the IGY to the Bureau of the Budget, and the submission of letters of support for the program to the Bureau of the Budget from the Departments of State, Defense, and Commerce, the Atomic Energy Commission, and the Office of Defense Mobilization, the President approved the program and included the requested amount for the National Science Foundation in support of the International Geophysical Year in a supplemental appropriation request for fiscal year 1955. Action by the Congress was approval of an initial appropriation of $2 million for the IGY program (Supplemental Appropriations Act of 1955, 83d Cong., 2d sess.). Subsequent appropriations to the National Science Foundation for the program have been $10 million (Independent Offices Appropriations Act of 1956, 84th Cong., 1st sess.); $27 million (Second Supplemental Appropriations Act of 1956, 84th Cong., 2d sess.); $2 million (Second Supplemental Appropriations Act of 1958, 85th Cong., 2d sess.). The total amount therefore appropriated to date for the IGY program is $41 million.

Fundings of the various projects in the United States IGY program have been administered through the regular grants procedure of the National Science Foundation, upon recommendations received from the United States National Committee for the IGY. Grants or transfers to 45 institutions or agencies have been made to March 31, 1958, totaling $34,871,678 (attachment B).

Two special reports on the IGY program have been made upon request to congressional committees. On March 28, 1956, there was transmitted to the chairman of the Subcommittee on Independent Office Appropriations and Government Matters, United States Senate, a special report on the International Geophysical Year prepared for the Senate Committee on Appropriations, which was published in May 1956 as Senate Document 124, 84th Congress, 2d session (attachment C). On May 1, 1957, members of the United States National Committee for the IGY, representatives of the Committee's Secretariat and the National Science Foundation appeared before the Subcommittee on Independent Offices, Committee on Appropriations, House of Representatives, at the request of the chairman, to give a progress report on the IGY program. This report was published as "Report on International Geophysical Year," Hearings Before the Subcommittee of the Committee on Appropriations, House of Representatives, 85th Congress, 1st session (attachment D).

Other Government agencies involved in the IGY

The National Science Foundation, in order to assure coordination, has worked closely with other Federal agencies having an active interest and role in the IGY. These include the Department of Defense, Weather Bureau, National Bureau of Standards, Coast and Geodetic Survey, and Geological Survey.

The Department of Defense is involved in the IGY program primarily in the Antarctic and earth satellite projects. In the case of the former, the Defense contribution includes all logistics support, construction of facilities, stationkeeping personnel, and transportation services. For the satellite program, agreements were reached with the Department of Defense to develop and supply suitable launching vehicles, procure range operation costs, place satellites in orbit,

and establish confirmation of the orbit, the latter involving certain parts of the ground electronics setup. The National Science Foundation agreed, as far as the earth satellite project was concerned, to furnish funds for the scientific instrumentation, parts of the electronics ground operations, the optical-tracking ground station network, and the substantial part of the radio-tracking and telemetry network.

III. RELATIONS WITH OTHER COUNTRIES PARTICIPATING IN THE IGY

As far as relationships with other countries are concerned, the IGY is a nongovernmental type of undertaking. Agreements and understandings are between the scientists and the scientific organizations of the countries and are not characterized by formal agreements, treaties, or other types of documentation that are used in the case of intergovernmental relationships.

To "qualify" as a participant in the IGY it is necessary only that the scientific organization representing a country agree to carry out certain appropriate scientific and geophysical programs within its own continental limits, possessions, or territories in which it has traditionally had an interest, that it appoint a special committee of appropriate scientists to organize and execute its scientific program, and that it agree to make the data therefrom available through planned IGY world data centers.

In order to assure ready availability of all data, the CSAGI has recommended the establishment of three "world data centers." One of these centers will be in the United States, one in the U. S. S. R., and the third divided between Western Europe and Japan.

The following principles will govern the operation of these centers:

1. Each world center will receive original copies of IGY data from countries that elect to use that particular center as the archives for their data. In general, it is anticipated that countries in the area of a given center will send their data to that center, although there may be exceptions. The important point is that all original IGY data will go to one or the other of the three centers now planned.

2. Each center will immediately make copies for the other world centers of the original data it receives and will supply these copies free of charge.

3. Any institution or individual may request from a world center copies of data, which will be supplied at the cost of reproduction. Every effort will be made to keep such costs low.

Thus three complete sets of IGY data are planned, conveniently located to supply requests from scientists throughout the world.

The United States World Data Center has been organized as a series of some 12 primary archives in the various disciplines, located at appropriate institutions and agencies, with a central coordination office presently at the National Academy of Sciences for handling requests.

Through the National Academy of Sciences representation at various international planning meetings held in connection with the IGY, American scientists have dealt with their colleagues from other nations in the planning of the overall scientific program. To date, 66 countries are actively involved in the IGY (attachment E).

Not all of these countries have been represented at the various international planning meetings referred to, but certainly all of the major countries have been so represented.

There has been held in the United States to date only one minor conference as far as IGY matters are concerned, and that was the Conference on Rockets and Satellites convened in Washington, D. C., the latter part of September and early October 1957. Representatives from 13 countries attended, including a delegation of three scientists from the U. S. S. R. A fourth Soviet scientist was present in his capacity as the vice president of the Special Committee for the International Geophysical Year under the International Council of Scientific Unions. This is the only occasion that Soviet scientists have visited the United States in connection with IGY activities. There was no formal exchange of IGY data at this time, although there were informal discussions on many unclassified aspects of satellite and rocket instrumentation and scientific research connected therewith.

IV. RESULTS OF THE IGY AND REMAINING CALENDAR OF EVENTS

Results of the IGY

Since the start of the IGY last July, stations throughout the world have been in operation. While a comprehensive evaluation of results achieved cannot as yet be made, certain real gains have been reported. In January of this year the

United States National Committee for the IGY prepared a status report on the first 5 months of the IGY, based primarily on United States activities. From this report it is clear that the IGY will produce basic scientific information that can be of great benefit to mankind.

Some of the things that have been learned, for example, include the recognition of a transient layer below the normal known layers of the ionosphere caused by intense solar activity. This effect is responsible for the blacking out of long-range radio communication circuits during periods of intense solar disturbance.

A second result is the confirmation of the simultaneous occurrence of auroral displays in both the northern and southern hemispheres. This serves to confirm the theory that aurora are produced by charged particles coming in from the sun that are deflected toward the two magnetic poles of the earth. The third interesting and highly significant observation is the possibility that the region high above the atmosphere, which had originally been thought to be relatively devoid of matter, now appears to contain electrified particles (ions), which may either be due to a miscalculation of the upper limits of the earth's atmosphere extrapolated from relatively low altitude observations or an extension of the solar corona to include the earth or a combination of both.

In the field of satellites, five scientific satellites have been launched as part of the IGY program. Two of these have been launched by the U. S. S. R.: 1957—Alpha (Sputnik I) on October 4, 1957; 1958—Beta (Sputnik II) on November 3, 1957. To date the Soviets have not released information on internal observations, although they have indicated that temperature measurements of the casing and certain interior parts were made. Presumably they are still working on the reduction of the telemetered observations.

The United States has placed three satellites in orbit: 1958—Alpha (Explorer I), launched by the Army on January 31, 1958; 1958—Beta (Vanguard 6-inch sphere), launched by the Navy on March 17, 1958; and 1958—Gamma (Explorer III), launched by the Army on March 26, 1958.

Reports on the experimental results of United States satellites were presented by the United States National Committee for the IGY at a special meeting at the National Academy of Sciences on May 1, 1958. These results, of a very preliminary nature, reported such things as the temperature ranges encountered by the satellite shell and its internal instrument package, the numbers of micrometeoric impacts, and, most important of all, certain cosmic ray counterresults that imply regions of high radiation intensity at distances of several hundred miles above the earth's surface. The exact nature of this radiation is not at the present time completely understood, but additional experiments will undoubtedly be planned to resolve the problem.

FUTURE CALENDAR OF EVENTS

Present–December 31, 1958: Continuation of active operational period at all IGY stations.

August 1–9, 1958: Fifth reunion of CSAGI, Moscow, U. S. S. R. (Major areas for discussions: publication of IGY data and other material, data flow and data centers, aspects of rocket and satellite programs, work in the Antarctic following IGY. Working groups in all disciplines will meet.)

Dates uncertain: Several planned launching attempts of additional IGY scientific earth satellites.

Summer or fall 1959 (post-IGY period): Possible international meeting of participating IGY national committees to be convened in the United States by the United States National Committee for the IGY. (Discussion of further results and closing out of affairs of CSAGI).

COUNTRIES PARTICIPATING IN THE INTERNATIONAL GEOPHYSICAL YEAR

Argentina
Australia
Austria
Belgium
Bolivia
Brazil
Bulgaria
Burma
Canada
Ceylon
Chile
China: Taipei
Colombia
Cuba
Czechoslovakia
Denmark
Dominican Republic
East Africa
Ecuador
Egypt
Ethiopia
Finland
France
German Democratic Republic
German Federal Republic
Ghana
Greece
Guatemala
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Japan
Korea, Democratic Republic of
Malaya
Mexico
Mongolian Peoples Republic
Morocco
Netherlands
New Zealand
Norway
Pakistan
Panama
Peru
Philippines
Poland
Portugal
Rhodesia, Southern
Rumania
Spain
Sweden
Switzerland
Tunisia
Union of South Africa
Union of Soviet Socialist Republics
United Kingdom
United States
Uruguay
Venezuela
Viet-Nam Democratic Republic
Viet-Nam (Republic)
Yugoslavia

April 15, 1958 (66 countries).

The CHAIRMAN. Thank you very much, Doctor.

The next witness is Dr. Lloyd V. Berkner, president and chairman of the executive committee, Associated Universities, Inc., of New York City.

Admiral, we are very glad to have you appear before us and testify. We welcome you.

We also understand that Mr. Frederick C. Durant III, of Massachusetts, former president of the American Rocket Society, is also here. Is that right, Mr. Durant?

Gentlemen, your testimony sort of interrelates with one another. The other day we found it very handy for their convenience, as well as that of the Committee, that those who are similarly situated each give their primary testimony and then the members of the Committee could address questions to both at the same time, because that makes it informal. I think that produces better results.

Dr. BERKNER. I will be happy to join Mr. Durant.

The CHAIRMAN. I personally do not like the stiffness of hearings. I like the informal atmosphere.

Do you have a prepared statement, Admiral?

Dr. BERKNER. Yes, sir.

The CHAIRMAN. You may proceed.

STATEMENT OF DR. LLOYD V. BERKNER,[28] PRESIDENT AND CHAIRMAN, EXECUTIVE COMMITTEE, ASSOCIATED UNIVERSITIES, INC., NEW YORK, N. Y.

Dr. BERKNER. Mr. Chairman, I am glad to be here with you this morning.

Mr. Chairman and members of the select committee, I am pleased to respond to the invitation of your chairman to discuss future policy and legislation on the subject of space exploration and research.

Since the first discussions of geophysical research with instrumented earth satellites in Europe in 1954, I have had the task of coordinating the plans for international research activity using instrumented earth satellites acting as the reporter for Rockets and Satellites of the Special Committee for the International Geophysical Year.

In less than 4 years we have progressed from the initial plans to the stage where three United States satellites are now circling overhead to collect scientific information of our environment that was beyond our fondest hope of access only a few years ago.

May I first take this opportunity to express my admiration to the Congress in their response to the request of the President and of the scientists through the National Science Foundation, for their perspicacity in providing financial means whereby our initial program of research with satellites is now being carried out.

In 1955, it was by no means clear to the uninitiated that a program of satellite launching would be justified or would produce such major scientific results.

I recall with pleasure, many hours of painstaking examination of these ideas by the House Appropriations Subcommittee under Chairman Thomas and by the Senate Appropriations Subcommittee under Chairman Magnuson. It is a tribute to the wisdom of our legislators that they were able to see the vital need for action, and to take the needed initiative in appropriating the funds that made possible the satellites. that are now carrying on their observations overhead.

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[28] Berkner, Lloyd V(iel), scientific adminstr; b. Millwaukee, Wis., Feb. 1, 1905; s. Henry Frank and Alma Julia (Viel B., B. S. in elec. engring, U of Minn., 1927; studied physics, George Washington U., 1933-35; m. Lillian Frances Fulks, May 19, 1928; children—Patricia Ann (Mrs. Charles Harrington Booth), Phyllis Jean. Engineer airways division, U. S. Dept of Commerce 1927–28; engr 1st Byrd Antarctic Expdn, 1928–30, elec engineer, Nat. Bur. of Standards, 1930–33, engr., physicist dept of terrestrial magnetism, Carnegie Inst. of Washington, 1933–41; exec sec research and development bd. Dept. Def., 1946–47; head sect on exploratory geophysics of atmosphere Dept. of Terrestieal Magnetism, Carnegie Instn. Washington, 1947–51, research asso, 1951——, also pres., trustee chmn. exec com Asso Univs., Inc. Cons. Research and Development Bd., since 1947, cons. Mass. Inst. Tech., 1950–52; cons. N. S. R. B., 1952–53. Spl. asst to sec. of state to organize and direct first Mil. Assistance Program of North Atlantic Pact, 1949; chmn. steering com., author official State Department report "Science and Foreign Relations," 1949–50. Mem. com. Rockefeller Service Awards, 1954——. Served as officer U. S. N., 1941–46, head radar section, Bureau of Aero, 1941–43, dir. electronics material br, 1943–45, tech planning officer future operations U. S. S *Enterprise*, 1945–46. U. S spl. Congrl. Gold medal, Silver medal Aero. Inst., Gold medal City of N. Y., Sci. award Washington Acad Scis, Commendation ribbon, Sec. of Navy; hon. officer Order Brit. Empire; Legion of Merit; Naval Res Medal with 1 star; Am. Def. Service medal with 1 star; Am Area, Pacific campaign medals, World War II Victory medal; Outstanding Achievement award U. Minn Fellow Am Phys. Soc., Inst. Radio Engrs., Am. Inst. Elec. Engrs. Arctic Ins. N. Am; mem Internat Council Sci Unions (chmn U. S. delegation to gen. assembly, Oslo, 1955), Nat Acad Sci., Nat. Research Council (policy com. div. internat relations), Internat. Sci. Radio Union (head U. S. A. delegation 9th Assembly of U. R. S I., Zurich, 1950, The Hague, 1954; v. p. 1954, pres. 1951–52, Am Geophys Union, A. A. A S, Council on Fgn. Relations, Theta Tau, Eta Kappa Nu. Acacia, Scabbard and Blade, Plum Bob, Democrat, Conglist Mason, Clubs; Cosmos (Washington); Explorers, Century (N Y. C). Contbr. to profl. jours. Home, 105 Mountain Av., New Rochelle, N. Y. Office: Associated Universities, Inc., 350 Fifth Av., N. Y. C. 1.

The very fact of these hearings illustrates the strength of our democratic processes in undertaking unusual measures that require great vision for the welfare and benefit of our citizens and of men everywhere.

The need for action at this time is clearly stated in the declaration of policy of the bill under consideration. I wish to testify in support of the general measures provided by that bill.

This need is more fully discussed in the President's message to Congress of April 2, 1958, and in the Introduction to Outer Space prepared by the President's Science Advisory Committee. To the former I fully subscribe, and to the latter I, of course, contributed as a member of that Committee.

In considering the future of space research, may I emphasize the great importance to every citizen of the knowledge that will be gained from such research.

Recently, under the title of "Man's Space Satellites," appearing in the bulletin of the Atomic Scientist—pages 106 to 111—of March 1958, I have described some of these research problems in considerable detail.

Many of these are discussed in much more detail in the Manual on Rockets and Satellites, Annals of the International Geophysical Year, that will be published by Pergamon Press next month in an illustrated volume of nearly 500 pages. This will be a very useful source of material.

Man's ability to improve his knowledge of meteorology is of immense immediate importance. The observations and measurements that can be made from space, looking down on the earth, are of a kind that give a new dimension to meteorological research.

We have, within our grasp, the means to see storms form and move and dissipate on a global scale—in fact, the means to count the number of storms from time to time and to see their interaction on one another.

We can see weather fronts grow in intensity, either visually or electromagnetically, see the genesis and movement of hurricanes, and obtain descriptions that, when coordinated with surface and radiosonde observations, can immensely improve the extent of our knowledge of weather.

The satellite can map the incoming and outgoing energy everywhere over the earth so that we can localize the energy sources that operate the atmospheric engine that gives us our weather.

The power of the satellite as a scientific instrument gives real hope that, coupled with other necessary observations and measures, man can learn the physical reasons why destructive droughts occur, or catastrophic windstorms and flood-producing rains are generated from a usually well-behaved atmosphere. Certainly, in the field of meteorology, even small advances in knowledge have values measured in billions of dollars annually.

Looking upward from the earth, man can now see the universe in its full chromaticity from the shortest to the longest wavelengths—from the slowest to the fastest particles coursing through space. In the satellite, he is no longer insulated by his blanketing atmosphere from the most interesting events of the universe.

He can now study all the clues to the physical behavior of the sun and the planets and the stars.

There is no doubt that these new studies in the next few years will lead to a much better understanding of nature—an understanding that will have many and diverse applications in our day-to-day life. Just as the study of astronomy and matter has given us our present day engineering with its power to turn nature to our benefit, so the new studies from space will vastly multiply this power.

Thus, even though the ticket to space is expensive, the payoff will be correspondingly high, and this can be prophesied with some certainty.

I mention the wide range of research that will be done from space vehicles, since it bears directly on the functions of the agency specified in section 6 of the bill, and particularly in section 6a4.

Almost every kind of scientific activity will be involved in space science in one way or another. In some cases, like astronomy or some aspects of geophysics and of physics, nearly the whole scientific activity will be carried out from a position of vantage in space.

Therefore, it would be completely unrealistic and undesirable for the Aeronautics and Space Agency to be responsible for all of the scientific activity to be done in space.

The bill under consideration wisely recognizes this problem, and provides that the Agency shall "arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautic and space vehicles, and conduct, or arrange for the conduct of such measurements and observations."

I interpret this language as meaning that any qualified scientist can plan and prepare a useful space experiment at his university or in his laboratory with the expectation of getting it into space with the cooperation of the Space Agency within the restrictions of the funds and technology available.

This means that the best of American science, wherever it is found, can have access to space through the means and cooperation that its Government provides. This provision ensures the healthy growth of space science and avoids a governmental monopoly on one of the important scientific activities of the future.

I deem it a most important and essential provision of the present bill.

Likewise, section 6 (b) (1) to (13) each become essential to the effectuation of this broad policy.

Please do not misunderstand that I would raise objection to the provision— of subparagraph 6 (a) (2) above—that the Agency have full authority to initiate its own space research directly.

Certainly the Aeronautics and Space Agency could not be effective without that authority.

But in practice, I would visualize that the Agency would serve the interests of American science best by encouraging and abetting and aiding scientists outside the Agency who are best qualified to design and carry out particular space experiments using the vehicles of the Agency.

But to do this, the Agency must develop its own scientific expertise and it will find many new space problems where only its own staff can devise and conduct the experiments.

The optimum balance of the Agency's aid to American science in the conduct of space experiments, and in the design of its own primary

scientific activities, will require great skills in administration. Therefore, this must be kept in mind in specifying the form of organization of the Agency.

One might argue that space technology should be developed under the wing of the military services. Undoubtedly, the space vehicles have military implications of their own, quite apart from the military capabilities implied in the ability to launch them.

Moreover, the great rockets required to launch heavy vehicles are available from the military stockpile, and at the moment the greatest skills in rocketry are under the supervision of our Department of Defense.

Consequently, it might be thought that greater economies of effort could be achieved in this way. Certainly strong arguments can be advanced for military control of future space development.

But these arguments have a certain superficiality that misses the significance of the space as a future social development. The extension of geography into space should be a peaceful project, as President Eisenhower has advocated.

Just as the initial planning for satellites for man's benefit was conducted in the friendly atmosphere of international scientific circles, so the future international discussions of space programs should be free of the rigid domination of the uniforms of the world.

This is not to say that the military organizations should not play their part in the conquest of space. Certainly they have many skills and facilities that are needed, and they have a legitimate interest in the subject.

But space conquest should be primarily for intellectual and social rather than military ends. We must recognize our conquest of space is a superb manifestation of man's control of his environment that far transcends its incidental military relevance to the interrelationships of men and nations. We must apply the results to our whole social and economic growth.

Our Nation faced a similar decision in planning the future of nuclear energy. Nuclear development has a relation to military strength at least equal to that of space technology. Yet our decision, and I believe it was right, was to place its direction under a civilian agency, the Atomic Energy Commission.

For nuclear energy had civil and peaceful as well as military implications. Whatever the defects of that organization, no one would suggest that it has in any way hampered the growth of United States military strength.

On the contrary, our nuclear military strength is in the unquestioned vanguard of our national scientific achievement.

At the same time, a civilian AEC provides the mechanism through which "atoms for peace" and other friendly international activities sparked by the atom, can aid in breaking down international tensions.

Similarly, the full scientific and social potentialities of space technology, in my opinion, can best be realized under a civilian Federal agency. The direct consequences of carefully designed space researches will react on every aspect of man's existence and will radically influence his adjustment to his environment.

The purely scientific problems involved are complex and their solution can be best achieved under civil auspices closely related to the academic atmosphere, because they transcend the normal limits of military technology.

Even the advanced rocket techniques that are needed must presently far outstrip the military needs, and, in fact, will often differ radically from military designs.

Certainly great laboratories will be required, and these should enjoy the intimate relationship to university activities that grows out of broad civil direction of national programs.

In the present state of unstable military equilibrium, it is natural that we should be concerned for our military strength and effectiveness. With the gravest consequences at stake, no nation can afford to tip the balance adversely by weakening its military strength.

But in facing the future of space technology with a biased emphasis on its military aspects, there is danger that we may fail to grasp the real opportunity for world leadership that space technology offers.

Militarization of broad problems such as space technology that affect all elements of our national community suggest a considerable danger of our Nation succumbing too completely to a psychology of military direction and control. Instead, a more balanced approach is needed through which all elements of our society, including the military, have an equal opportunity to contribute.

We must not forget that it was the Soviet Academy of Sciences and not the Red army, that negotiated the plans for the launching of the first earth satellites.

I would submit, therefore, that he specifications for Aeronautics and Space Agency contained in the declaration of policy of the bill in its present form, are not only wise, but in themselves suggest a civilian agency for their effectuation.

Moreover, the consolidation of the space activities, with the aeronautical activities now under the National Advisory Committee for Aeronautics, appears to be the best possible course. In the NACA, there is already our best national skill in aeronautical research. The future of space development is inevitably related to these skills very closely.

The addition of the responsibility for American space activities to the present responsibilities of the NACA represents a means for orderly growth of these skills that will strengthen both the aeronautical and the space capabilities of American science and engineering.

The enlarged Agency, to be most effective, must grow with a strong academic flavor to develop its strength in close collaboration with the science of American universities and institutions.

Therefore, its development should be more toward the academic, as contrasted to the commission form or organization. Here we must recall that the NACA, with its Board and its Director, has developed an effectiveness that is the mainstem of American aeronautical development and is the envy of the rest of the world.

I would, therefore, urge strongly and unambiguously that the organization of the Agency as visualized in the present bill be retained.

The NACA form of basic policy determination and direction has, in my opinion, already won the confidence of American science and industry. It has demonstrated its capability to cooperate with the Armed Forces to a maximum of effectiveness, thereby relieving them of much responsibility auxiliary to their task. It is a proven organization and it should be retained.

The challenge of space will not be simple to meet. From this challenge will evolve instruments and techniques and opportunities that

will enable man to view his problems with a new perspective, that will provide him with incalculable advantage.

Space technology represents a broad intellectual challenge that must be met by an equally broad response from all elements of our national community.

In my opinion, the present legislation recognizes that challenge and provides the means for the national character of the response. It subordinates expediency to the course of wisdom.

Thank you, Mr. Chairman.

The CHAIRMAN. In accordance with our understanding, we will hear from Mr. Durant.

The next witness is Mr. Frederick C. Durant III, of Everett, Mass., former president of the American Rocket Society and International Astronautical Federation.

You are connected with Arthur D. Little, Inc.?

STATEMENT OF FREDERICK C. DURANT III, FORMER PRESIDENT, AMERICAN ROCKET SOCIETY, AND INTERNATIONAL ASTRONAUTICAL FEDERATION

Mr. DURANT. I was for several years but last summer I joined the AVCO Research Laboratory.

The CHAIRMAN. We are glad to have you with us, Mr. Durant.

Have you a prepared statement?

Mr. DURANT. Yes, sir; I do.

The CHAIRMAN. I notice you have written two articles, one entitled "Commission on Astronautics, Academy of Sciences, U. S. S. R.", and the other one the International Astronautical Federation, IAF.

Mr. DURANT. Those I furnished to Dr. Sheldon of your staff simply as background material for your committee.

The CHAIRMAN. I think without objection we will insert both these articles in the record after you have completed your main statement.

You may proceed, Mr. Durant.

Mr. DURANT. Thank you.

Mr. Chairman and gentlemen, in contrast to all of the distinguished scientists who have appeared before you during the past few weeks, I have no such pretension. I am an engineer with chemical and aeronautical background.

However, I have devoted much of my professional life to rockets and guided missiles and, avocationally, to professional societies concerned with various aspects of space flight.

The record shows that my role has been one of an organizer and administrator. In a sense, I have promoted space flight for the past 10 years because of a deep conviction that man, by moving into this new dimension with instrumented and manned vehicles, could achieve a greater understanding of nature and himself.

Viewed objectively, space flight is inherently an international endeavor. Beyond the thin shield of the earth's atmosphere lies limitless space which has no national boundaries. The minds of educated men all over the world are being stirred at an increasing rate in the realization that exploration and research in space are about to begin. The tools and vehicles for this accomplishment are already at hand.

Only a few countries have the technical and production capabilities to commence this exploration at this time. But the minds of all men are stimulated by this thrilling prospect.

Brilliant scientists and engineers in all countries would like to study, work, and become identified with the evolution of astronautics. The absence in many nations of the all important rocket launching vehicles needed to carry instruments into space in sounding rockets and satellites is causing a natural frustration. This frustration, because of human nature, can lead to envy and bitterness.

The United States is currently engaged in setting up a national agency to administer and direct a space flight program.

What I would like to urge is this: that due consideration be given to the many advantages which would accrue to this country, in particular, and to the advancement of science, in general, by wide international cooperation with other nations in space flight research.

Accordingly, I would urge that the United States assert its leadership in welcoming the ideas and efforts of foreign scientists and engineers in the planning and execution of space flight projects.

To this end, I suggest that the following programs be established in conjunction with any national space agency:

1. A program to collect and disseminate information regarding plans and progress of the United States space flight program, as well as those of other countries.

The material to be disseminated would be written for both popular consumption as well as for the scientifically and technically educated. Such material might well take the form, initially, of quarterly bulletins as well as specific reports on particular projects. It is suggested that dissemination should be in English, French, German, Spanish, Italian, and Russian.

The United States Information Agency and the International Astronautical Federation, with its representative member societies in 21 nations, would seem to be appropriate agencies to cooperate in this work.

It is suggested further that close liaison be established overseas in the administration of such a program with the Advisory Group for Aeronautical Research and Development (NATO); USAF Air Research and Development Command office in Brussels, Belgium; the Office of Naval Research Liaison Office at London, England; the United States Army Research and Development Liaison Group in Frankfurt, Germany; and the Science Attaché program of the State Department.

2. The establishment of a significant number of graduate level scientific research scholarships with credit for advanced academic degrees.

Such scholarships should be on a funded basis, based upon international competition as well as, perhaps, on an exchange basis.

Nonsecurity-classified research would be conducted on instrumentation for use in sounding rockets and satellite vehicles, as well as design and engineering concepts for manned and unmanned space flight.

All scientific disciplines should be covered including social and legal aspects.

Funds would be provided to cover transportation, tuition, and at least minimum living costs.

It might be expected that the aviation and guided missile industry would sponsor a number of such scholarships.

3. A continuing program of international competition with regard to experimental research to be conducted in United States satellites.

The choice of experiments to be performed in United States satellites to date has been solely from the proposals from United States scientists. I am certain that the opportunity of foreign scientists to play a part in satellite research would bring hundreds of new scientific minds to bear upon the subject.

In this program, foreign scientists would study and recommend, not only the kind of measurement to be performed, but also suggest measurement techniques and instrumentation design.

It is folly to think that we have in this country a corner on the brains market. If, at the outset of the Vanguard program, the United States had set aside 1 of the 6 planned satellites to be instrumented in accordance with the results of an international scientific competition, I submit that the world reaction to the early Vanguard launching failures would have been one of shared sympathy and compassion rather than the gloating that occurred.

4. I propose that the United States take the initiative and, through the United Nations, call for an "International Conference on the Peaceful Applications of Rocket Power."

Such an international conference would affirm United States interest in rockets for peace, just as 3 years ago we took the initiative and called for an atoms for peace conference.

The International Astronautical Federation would be of great assistance in the organization and administration of this conference under the advice and assistance of the United Nations.

It is generally accepted among nuclear physicists that the Geneva Atoms for Peach Conference was healthy and aided greatly in dissemination of information and in the stimulation of new ideas. I am certain that similar results would accrue from a rockets for peace conference.

In summation, I am convinced that the establishment of the above program would assert the leadership of the United States and affirm our appreciation of the international aspects of astronautics.

The United States did assert this leadership on July 29, 1955, when President Eisenhower announced the establishment of the United States satellite program for the International Geophysical Year. But, to maintain leadership a continuing program of contact, liaison, and dissemination is necessary.

This country is not recognized currently as displaying leadership in astronautics. Precious time is being lost. The educated world is hungry for easily obtainable factual information. Foreign scientists and engineers crave an opportunity to participate in space research. The youth in this country and abroad yearn to become knowledgeable in astronautics so that they can appreciate and taste fully the fruits of space research in the next decade.

Finally the United States has the opportunity to become a leader in astronautics and to share with other nations our plans and programs for space research. The return benefits which could accrue to the United States would be positive and widespread; not only from a scientific and technical standpoint, but from the respect and enthusiasm we will elicit for sharing with others our astronautical heritage.

In thus asserting leadership by extending a friendly invitation to cooperate, a first step will be made along the way to possible future partnership in space projects on a global basis.

It is envisioned, hopefully, that cooperation at some future date may be extended to equipping and staffing of tracking and communications stations, as well as to the funding and production of international space vehicles.

At some point in the years ahead, it will become highly inefficient not to cooperate because of the magnitude of cost of large astronautical projects, such as flights to the planets.

A first step has to be taken by some nation. I hope it will be the United States.

Thank you.

(The documents submitted by Mr. Durant follow:)

COMMISSION ON ASTRONAUTICS, ACADEMY OF SCIENCES, U. S. S. R.[1]

(F. C. Durant III)

The bold accomplishment of satellite flight by the U. S. S. R. did not spring from short-term intensive effort. Nor was it dependent upon scientific breakthroughs, superfuels and metals, or new sources of power. The Russian achievements were the product of a coordinated program, planned by a group of competent scientists comprising the Commission on Astronautics of the Academy of Sciences, U. S. S. R.

This body had the responsibility to organize the program, to assign the appropriate research tasks, and to see that this work was carried out. Their job was to identify the basic problems which had to be answered before scientific research satellites could be launched, and obtain the answers. They were eminently successful.

These men were not engineers. The tasks of design, production, logistics, and launching were left to the military. The controlling body, however, was the Commission on Astronautics.

The Soviet Academy of Sciences is an elite organization composed of hundreds of scientists assisted by practical experts and technicians. Membership to the academy brings a special stipend and great professional prestige. In essence it is the centralized body of control of all Soviet science. The interests of the Academy range from pure science through engine design to medieval history. In 1952 it had 40 commissions and committees, 14 museums, 4 observatories, 57 institutes, 38 research stations, and 15 laboratories. Through these and other agencies it directs the work of thousands of scientists and technicians throughout the Soviet Union. Policy and direction flow from the U. S. S. R. Council of Ministers through the Chief Scientific Secretary, appointed by the Communist Party. The current Secretary is A. V. Topchiev. The President of the Academy is a respected organic chemist, A. N. Nesmeyanov.

Because Russian science is under state domination, heavy-handed, unenlightened administration might easily stifle progress and creative talent. Evidence during at least the last few years, however, indicates that great care has been taken not to demand practical results too quickly but rather to assign requirements, responsibility, and authority and let the scientists run the show.

The Commission on Astronautics was officially established early in 1955 under the Academy's Astronomical Council. Its official title is "The Interdepartmental Commission for the Coordination and Control of Scientific-Theoretical Work in the Field of Organization and Accomplishment of Interplanetary Communication of the Astronomical Council of the Academy of Sciences of the U. S. S. R." The fundamental task of the Commission is "* * * to assist in every way the development of scientific-theoretical and practical work in the Soviet Union concerning questions of studying cosmic space and the accomplishment of astronautics."

The responsibilities and powers of the Astronautics Commission are specific and extensive. The Commission is charged with—

[1] Portions of this article were published in the December 1957 issue of Missiles and Rockets.

1. "Taking actions which secure the active participation of academic and branch scientific-research establishments in work for the investigation of cosmic space."
(Direct appropriate institutes and laboratories to earmark personnel and time for research on problems assigned by the Commission.)
2. "Organization of work on drawing up problem plans and programs of scientific investigations on the fundamental trends of astronautics." (Draw up a long-range development program and identify the important areas of ignorance to be investigated)
3. "Broad attraction of scientific-research establishments, of universities and individual investigators to the solution of problems to secure the realization of flight into cosmic space " (Sell astronautics as an exciting new field of research to the scientific fraternity.)
4. "Coordination of scientific activities of individual research institutions on the problems of astronautics " (Make certain that there is a horizontal flow of appropriate information between the various research institutes.)
5 "Popularization of the tasks and achievements in the field of astronautics." (Educate the population at various levels of intelligence in the technical feasibility of astronautics and the potential value of satellite and other space research.)

In addition, the Commission shall—

(*a*) Review the plans and reports of the "scientific research institutes which work on the program controlled by the Commission."

(*b*) Sponsor scientific conferences on astronautical problems.

(*c*) Serve as the award committee in stimulating the submission of scientific work in competition for the triennial K. E. Tsiolkowski gold medal, established in 1954

(*d*) Maintain, through the Foreign Section of the Academy of Sciences, contact with the scientific organizations in foreign countries which are concerned with high-altitude research and space flight.

The Chairman of the Commission on Astronautics is Academician L. I. Sedov. Sedov is a distinguished physicist who in the past has been known for his works in analytical mechanics and gas dynamics He presides over 26 other members who, currently, are (see tab A). By and large this is a distinguished group of scientists Many are leaders in their fields. Almost any United States scientist concerned with upper atmosphere research or astronomy will recognize some of the names.

For example, a leading Harvard astronomer told me recently that, in his opinion, V A. Ambartsumian is one of the world's top astronomers. Certainly Ambartsumian impressed those who heard him speak at the Cosmical Gas Dynamics Symposium at Cambridge, in June of this year.

N. P. Baravashev, an astronomer, is director of the Kharkov Observatory and well known for his book on the geophysics of the moon and the planets. In February of last year he was chairman of an important conference on the physics of the moon and the planets at Leningrad State University

A A Blagonravov is an armaments specialist and a member of the Presidium of the Academy of Sciences.

N N Bogolyubov is a mathematician well known for his work in applied mechanics (vibration theory), quantum mechanics, and field theory.

V F Bolkhovitinov is an aircraft designer who, among other achievements built the first turbojet airplane in 1942

D N Frank-Kamenetskiei is a physical chemist who has studied combustion flame phenomena.

V. L Ginzburg has written of the potential value of earth satellites in verification of the general theory of relativity.

Peter L Kapitsa is, of course, a nuclear physicist and a cryogenicist of international fame His place on the Commission is probably to backstop problems of low-temperature rocket propellents as well as to consider nuclear-rocket powerplants

A. G. Karpenko, the Scientific Secretary of the Commission, has written on the problems of temperature regimes of satellite vehicles.

M A. Lavrent'ev is a prominent mathematician.

A. G. Masevich is a woman astronomer in charge of the official tracking program for IGY earth satellites

D E Okhotsimskii is best known for his writings on rocket propulsion and the orbits of earth satellites.

P. P. Parenago is recognized as an outstanding astronomer known for his studies of electromagnetic phenomena.

Yu. A. Pobedonostsev is an oldtimer whose work and interest run back to the Russian Rocket Society (Mosgird) days of the early 1930's.

K. P. Stanyukovich is a noted Soviet physicist whose name is associated with aerodynamics and explosion phenomena.

A perusal of Project Rand's F. J. Krieger's excellent Casebook on Soviet Astronautics, parts I and II, indicates clearly that a substantial number of members of the Commission on Astronautics have been active in popularizing astronautics Through the medium of the press and various conferences, basic principles of space flight have been expounded.

One important announcement may be forthcoming in the next several weeks—the naming of the first recipient of the Tsiolkowski gold medal This award will be made "to Soviet and foreign scientists for original work of major significance in the development of astronautics." The closing date for this competition was April 1, 1957. It could be expected that the individual (or individuals) named will be those who have played key roles in the development of the first sputniks.

With the successful accomplishment of the initial steps in astronautics, the Commission on Astronautics is undoubtedly at work on the more obvious follow-on projects, namely:

(a) More and larger satellite vehicles;
(b) Recoverable satellites;
(c) Space medical research in satellites;
(d) Lunar impacting vehicle;
(e) Circum lunar vehicles.

That these projects are technically feasible is no longer a question. The question is, rather, how far along is the U. S. S. R. in their prosecution. If they are all accomplished in 1958, the United States will really have a hard time catching up, and a still harder time in beating the Soviets to later firsts in space research.

LIST OF MEMBERS OF THE INTERDEPARTMENTAL COMMISSION ON INTERPLANETARY TRAVEL OF THE ASTRONOMICAL COUNCIL OF THE ACADEMY OF SCIENCES, U. S. S. R.

1. Sedov, L. I., academician, chairman.
2. Petrov, G. I., corresponding member, Academy of Sciences, U. S. S. R., Vice Chairman.
3. Levin, B. Yu, doctor of physicomathematical sciences.
4. Lavrent'ev, M. A., academician, Mathematical Institute, Academy of Sciences, U. S. S. R.
5. Kapitsa, P. L., academician, Physical Laboratory, Academy of Sciences, U. S. S. R.
6. Bogolyubov, N. N., academician, Mathematical Institute, Academy of Sciences, U. S. S. R.
7. Blagonravov, A. A., academician, Mechanical Engineering Institute, Academy of Sciences, U. S S. R.
8. Ambartsumyan, V. A., academician, Academy of Sciences, Armenian, U. S. S. R.
9. Lebedev, S. A., academician, Institute of Precision Mechanics and Computer Engineering, Academy of Sciences, U. S. S. R.
10. Parenago, P. P., corresponding member, Academy of Sciences, U. S. S. R, State Astronomical Institute.
11. Ginzburg, V. L., corresponding member, Academy of Sciences, U. S. S. R., Physical Institute.
12. Trapeznikov, V. A., corresponding member, Academy of Sciences, U. S. S R., Institute of Automatics and Telemechanics, Academy of Sciences, U. S. S. R
13. Petrov, B. N., corresponding member, Academy of Sciences, U. S. S. R, Institute of Automatics and Telemechanics, Academy of Sciences, U. S S. R.
14. Frank-Kamenetskii, D. N., doctor of chemical sciences.
15. Khaikin, S. E., doctor of physicomathematical sciences, chief Astronomical Observatory.
16. Pokrovskii, G. I., doctor of technical sciences, Military Air Academy.
17. Vanichev, A. P., doctor of technical sciences.
18. Pobedonostsev. Yu, A., doctor of technical sciences.
19. Duboshkin, G. N., doctor of physics-mathematical sciences.
20. Stanyukovich, K. P., doctor of technical sciences, Moscow Higher Technical College, im. "Bauman."

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21. Bolkhovitinov, V. F., doctor of technical sciences, Military Air Academy.
22. Florov, Yu. A., leading constructor, TsIAM.
23. Barabashev, N. P., academician, Academy of Sciences, Ukraine S. S. R.
24. Masevich, A. G., candidate, physics-mathematical science.
25. Markov, A. V., doctor of physics-mathematical science.
26. Okhotsimskii, D. E., candidate, physicomathematical science.
27. Karkenko, A. G., scientific secretary of the commission.

(Signed) L. SEDOV.

THE INTERNATIONAL ASTRONAUTICAL FEDERATION (IAF)

F. C. Durant III

Why it was founded

The rapid development of military rockets during World War II was led to a growing public interest in rocketry and in the possible use of rocket power for the attainment of space flight. Flight outside the earth's atmosphere has been a dream of man for generations It has long been appreciated, from a theoretical standpoint, that rocket power is the key to flight into space, because it is currently the only feasible propulsion system not requiring the oxygen in the atmosphere for combustion. Rocket powerplants are completely self-contained.

The advancement of rocket technology during and since World War II, together with other advances in electronics, metallurgy, supersonic flight, and atomic power, has led professional scientists and engineers to a startling conclusion: Space flight might be achieved in their generation. The announcement of satellite vehicle programs is recognized as an important step in this direction.

Few of the pioneers of rocket power had in mind the use of rockets as weapons of war The realization of space flight and space research as a peaceful enterprise was more often their aim. Many experts in astronautics are convinced that the full appreciation of the potentialities of space flight is a scientific, technical, and economic problem of such magnitude that it cannot be solved by one nation alone; unselfish international cooperation is necessary.

The First International Congress of Rocket and Astronautical Societies was held in 1950 at Paris. Its purposes were to discuss the possibilities of merging the influence of national societies and to enlarge upon the efforts of these societies through an international exchange of experiences and ideas. Subsequent annual congresses have been held at London, Stuttgart, Zurich, Innesbruck, Copenhagen and Rome and Barcelona. Organizations from 21 nations are now members of the IAF. At all of these congresses, the delegates of the national member societies have been impressed by the excellent spirit of cooperation. Although the opinions of the delegations have occasionally differed on technical points, agreement has been reached on all important issues. This proof of harmony and fellowship augurs well for the young federation. The constitution as a working document and the activities of the officials, the council, and the member societies are important, but the cornerstone of the IAF is the element of good will among men of many nations.

The aims

The general aims and objectives of the International Astronautical Federation, as described in its constitution, are listed below: "The IAF shall exist to promote and stimulate the achievement of space-flight as a peaceful project.

"The IAF shall do all in its power to secure the widespread dissemination of technical and other information on space-flight through the medium of exchange of publications, collaboration on research, etc., as between its members.

"The IAF shall do all in its power to stimulate public interest in, and support for, the idea of space-flight through the medium of books, press, lectures, radio, films, etc.

"The IAF shall do all in its power to stimulate work on astronautical subjects by international and national research and development establishments, universities, commercial firms, individual specialists, etc."

Membership

The following organizations are current members of the IAF:

Argentina: Asociacion Argentina Interplanetaria, the University of Cuyo (affiliate member).

Austria: Oesterreichische Gesellschaft fuer Weltraumforschung.

Brazil: Sociedade Interplanetaria Brasileira.

Chile: Sociedad Interplanetaria Chilena.
Denmark: Dansk Interplanetarisk Selskab.
Egypt: Association Egyptienne Astronautique.
France: Societe Francaise d'Astronautique.
Germany: Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt, Deutsches Raketen-und Raumfahrt-Museum e. V., Deutsche Arbeitsgemeinschaft fuer Raketentechnik.
Great Britain: British Interplanetary Society.
Italy: Associazione Italiana Razzi.
Japan: Japanese Astronautical Society.
Jugoslavia: Astronauticko Drustvo.
Netherlands: Nederlandse Vereniging voor Ruimtevaart.
Norway: Norsk Astronautisk Forening.
Poland: Polskie Towarzystwo Astronauticzne.
Spain: Agrupacion Astronautica Espanola.
Sweden: Svensk Interplanetarisk Selskap.
Switzerland: Schweizerische Astronautische Arbeitsgemeinschaft.
Union of South Africa: South African Interplanetry Society.
United States: American Rocket Society. American Astronautical Society.
U. S. S. R.: Commission on Astronautics, Academy of Sciences.

These national societies, excluding affiliates, comprise more than 11,000 members. A high percentage of the membership is made up of professional men representing all major fields of science and engineering technology. This wide variety of professions in an excellent demonstration of the fact that astronautics draws upon nearly every field of human knowledge. It follows, therefore, that cooperation in all of them is needed for the exploration of space to be achieved.

The IAF Council meets with delegates of member societies at the annual congresses. Besides IAF business, discussed in plenary sessions, several days are set aside for the presentation and discussion of technical papers.

Several administrative and scientific committees have been appointed by the IAF Council. Some of their activities include: liaison and cooperation with other international organizations; recommendations for standardization of astronautical nomenclature and library classification systems; a multilingual glossary of astronautical terms; and the publication of an international astronautical journal. Astronautica Acta. Each year, the Guenter Loeser Memorial Medal is awarded at the congress to the author of the paper adjudged most important.

A permanent secretariat, an archive, and an astronautical library are maintained at the IAF headquarters at Baden, Switzerland. An IAF bulletin is published regularly and sent to member societies.

The next congress will be held at Amsterdam, August 25–30, 1958. Further information may be obtained from: Ing. Josef A. Stemmer, Secretary, International Astronautical Federation, Post Box 37, Baden, Switzerland; or from the IAF officer nearest you:

President: United States: Mr. Andrew G. Haley, 1735 DeSales Street NW., Washington, D. C.
Vice Presidents:
United Kingdom: Dr. Leslie R. Shepherd, 28 Avon Road, Chilton, Berks, England.
Argentina: Ing. T. M. Tabanera, Tucuman 950, Buenos Aires, Argentina.
France: Gen. Paul J. Bergeron, 2, rue Voisembert a ISSY, (Seine), France.
U. S. S. R.: Prof. Leonid I. Sedov, Chairman, Commission on Astronautics, Academy of Sciences, Moscow, U. S. S. R.
Sweden: Ing. Åke Hjertstrand, Engelbretsgatan 12$^{\text{iv}}$, Stockholm, Sweden.
Poland: Prof. Kasimierz Zarankiewicz, Al. Wawelska 19 m. 20, Warsaw, Poland.

The CHAIRMAN. Now, as to any questions asked by the members of the committee, might I suggest they respond like a panel. If the other one agrees, just simply say "I agree." But if you disagree, in whole or in part, then express it at that time. Of course, you will have an opportunity of revising and editing your remarks.

If you want to enlarge on questions answered extemporaneously, you have permission to do so when you edit your remarks.

Mr. HAYS. Thank you, Mr. Chairman.

I would like to thank both our witnesses for excellent statements. They are quite consistent with each other on this emphasis on international cooperation.

I am confident that both Admiral Berkner and Mr. Durant will have an interesting response to this question:

To what extent are we now able to secure the cooperation of the Soviet scientists in our development of this program?

Dr. BERKNER. Mr. Hays, there has been substantial cooperation with the Soviet scientists in connection with the flight of the satellites. There has been release of information by both the United States and by the Soviet Union concerning the location of their satellites and, to some extent, concerning the scientific information acquired by the satellites.

On April 27, there was published in Pravda a very important review, of which I have a copy in teletype form here, of a scientific publication which has been released by Moscow. I have not yet received the original. This indicates a very extensive release by the Soviet Union of scientific data obtained during the operation of Sputnik I, and some information obtained during the operation of Sputnik II.

I invite your attention to the fact that the Pravda publication was sufficiently complete to give us a rather good insight into the principal scientific results which they obtained from the flight of those satellites.

Tomorrow morning, at the National Academy of Sciences, representatives of our National Academy will release certain scientific information that has been obtained to date. This United States information will be released by a panel of our leading satellite experts.

Consequently, I think it can be said categorically this morning that the interchange of scientific information on the subjects of satellite reseach is really in remarkably good shape.

Mr. HAYS. Have you discovered to any extent whether the Soviet Union scientists have been inhibited by military considerations in making the information available?

Dr BERKNER. They certainly have been in some respects. Their inhibitions have been very similar to our own inhibitions with respect to our launching techniques.

At the conference on rockets and satellites held in Washington last year, September 30 to October 4, the Soviets released full information on their so-called meteorological rocket. Their data included pictures and technical details of a rocket which is capable of flight and outer atmospheric research to an altitude of approximately 100 miles.

They announced at that time that they also had what they called a geophysical rocket that was capable of going 200 miles. I believe in recent flights this rocket has gone somewhat higher.

I asked the leader of that delegation, Professor Blagonravov, for technical information on this rocket. He said quite frankly it was not yet declassified. He hoped sometime in the near future to be able to provide the full information available on this type of rocket.

Mr. HAYS. It is generally true that, by temperament, scientists are eager to share information, their pursuit of knowledge carries with it a desire to give knowledge to others and, in turn, acquire knowledge from them?

Dr. BERKNER. Yes. I might add there may be a bit more pecuniary interest in the matter since as one acquires knowledge from others, he is able to extend the scope and effectiveness of his own theories.

Mr. DURANT. I might like to add one point.

In addition to the channel of communication built up in the IGY through the national committees, which is what Dr. Berkner was referring to, I believe, another channel has been established through the International Astronautical Federation. In 1955, the first Russians came to our annual conference.

In 1956, the Commission on Astronautics of the Academy of Sciences at Moscow joined the federation.

Last year, 1957, there were four papers presented at the Barcelona Conference, which followed immediately after the meeting Dr. Berkner referred to, and it is another channel.

Professor Sedov was the Chairman of this Commission and attended all these meetings.

The IAF is another channel of communication. Since Professor Sedov has accepted one of the vice presidencies it is hoped that this additional channel can be enlarged and strengthened.

Mr. HAYS. Again, from the scientists' standpoint, we have every reason to believe that with the firming up of peace conditions, so that world tensions may be relaxed, fears dissipated, there will be a tremendous impetus to the sharing of scientific knowledge. That is one goal that the scientists would earnestly seek for; is it not?

Dr. BERKNER. Mr. Hays, certainly within the limits of security classification set up by each nation for its own security, one would hope that full and free interchange of information might take place.

I might add that when one looks at the general properties of the present Government of the Soviet Union, one supposes that the improvement of exchange of information will inevitably soften the attitude of the Soviet Government which seems to be very hard in some respects at the present time. In the field of science I believe one can say that these attitudes are softer than they are in any other field in which we deal in with the Soviet Union. This, I believe, is an important factor in the relief of tensions.

Mr. HAYS. Generally speaking, is it true that the Russian scientists are not particularly interested in the political ideological basis of the Soviet Government's structure? In other words, they are not involved on the whole, are they, in the political life of the Soviet system?

Dr. BERKNER. Mr. Hays, that varies from individual to individual. Many of the Soviet scientists are almost totally free of any strong political feeling. On the other hand, without question, there are some scientists whom I know, who are confirmed Communists and who are strong upholders of the Communist social and imperialistic ideology.

Mr. DURANT. My experience and contacts support this view.

Mr. HAYS. That shows up in their scientific performance?

Dr. BERKNER. It certainly does.

Mr. FULTON. It varies also from field to field. In the fields of biology and genetics there has been a complete switch-about by the Russians.

Dr. BERKNER. That is true. We don't know how complete this switch-about is.

Lysenko is seated in a position of considerable authority in the Soviet Union. Vavilov has not again appeared on the scene. Yet there is an indication that, by force of necessity, the correct interpretation of scientific results is an essential to the growth of any part of the Soviet activities. The truth in science must be accepted by the Soviets as well as by free people.

Mr. HAYS. There is no evidence of switch-about, then, in the field of space, basic research and earth-satellite exploration?

Dr. BERKNER. As nearly as I can tell, they are doing a solid job. In studying this release there is every reason to believe that it is absolutely correct in every detail. It contains much useful information to us, sir.

Mr. HAYS. Admiral Berkner, I would like to have that release as a part of the record.

Dr. BERKNER. I have already given it to the counsel, Mr. Hays.

Mr. HAYS. Without objection, the release will be made a part of the record, Mr. Chairman.

The CHAIRMAN. The release, without objection, may be made a part of the record.

(The material referred to follows:)

U. S. S. R. NATIONAL AFFAIRS

APRIL 29, 1958.

FIRST SPUTNIK RESULTS PROVE VALUABLE

Moscow, Soviet Home Service, April 27, 1958, 0700 GMT—L.

(Material from Pravda: "The Soviet Artificial Earth Satellites—Some Results of Scientific Research on the First Two Soviet Artificial Earth Satellites.")

(Text:) The successful launching of the first artificial earth satellites marks the beginning of man's penetration into cosmic space. The artificial satellites open up the widest prospects for many very important scientific research projects. Great scientific and practical interests are presented by the study of the ionosphere and the mechanism of its foundation, the influence of the radiation of the sun and cosmic rays on the earth's atmosphere, the study of the density and temperature of the magnetic and electroscopic fields at great heights, and so on.

The solution of these problems demands carrying out direct experiments at heights of hundreds and thousands of kilometers from the surface of our planet. The chance of carrying out such experiments appeared with the creation of the artificial satellites, with the necessary scientific measurements to be taken at great heights over various areas of the earth over a prolonger period.

Only after the building of intercontinental ballistic missiles in the Soviet Union was it possible for the first time to launch an artificial earth satellite. The outstanding qualities of design in this rocket enabled satellites with a heavy load of scientific apparatus to be put into an orbit. The launching of the earth satellites with heavy loads of scientific apparatus enables complex series of scientific research projects to be carried out; and the fact that they are carried out simultaneously greatly increases their scientific value. Only by launching large artificial satellites is it possible to solve the problem of creating permanently operating cosmic laboratories, for realization of interplanetary flights.

The first Soviet artificial earth satellite was put into an orbit with a perigee—the nearest point of the orbit to the earth—of 228 kilometers and an apogee—the farthest point of the orbit from the earth—of 947 kilometers.

In the case of the second satellite, the corresponding figures were 225 and 1,671 kilometers, respectively. The time of revolution around the earth at the beginning of the flight was 6.17 minutes for the first satellite and 103.75 for the second.

During the satellites' movement along orbits at the aforementioned range of heights, it was possible to carry out research on study of the upper atmosphere,

determination of the density of the atmosphere, study of the diffusion of radio waves, and so on. On the other hand, density of the atmosphere at these heights is sufficiently thin, and therefore the measuring of primary components of cosmic radiation, the spectrum of the short-wave radiation of the sun, and so on was not distorted.

Scientific tasks have also determined the selection of the angle of the orbit to the plane of the earth's equator, of approximately 65°. The advantage of such an orbit is that when the satellite goes into orbit, the installed scientific apparatus can take measurements over various latitudes It is worth noting that putting a satellite into an orbit at a greater angle to the Equator is a far more complicated task than putting it into an orbit close to the Equator's orbit.

During the period of its existence, from October 4, 1957, to January 4, 1958, the first Soviet satellite made 1,400 circuits around the earth. The second satellite completed about 2,370 circuits from November 3, 1957, to April 14, 1958. With the aid of the first Soviet artificial satellites, the outlined program of scientific research was carried out successfully. A few preliminary results of the research are given below. On the whole, the accumulated information is very extensive, and work is continuing on it.

Radiotechnical and optical observations of the artificial earth satellites

Insofar as analysis of the change in the orbit of the satellite in time makes it possible to assess the density of the upper layers of the atmosphere, there is great significance in the study of the movement of the satellites. The elements of the orbits of the earth satellites can be determined on the basis of observations carried out by radiotechnical and optical methods. Among the radiotechnical methods used were radio position finding and the observation of the Doppler effect during reception of radio signals from the satellite.

The Doppler effect is as follows: Upon the approach of the object carrying the radio transmitter to the radio reception point, the frequency of signals received is increased and upon the object's moving away it is reduced.

The change in frequency depends on the speed of approach and recession. Under conditions of the satellites' flights, the speed of approach and departure of the satellites over the radio receiver were so great that the Doppler effect, which permits observation on a normal radio receiver, could be used to register the moment of the satellite's passing at its nearest point to the observation center, and also to define the distance to the satellite and its speed.

During radio observation of signals from the first and second satellite, the measurement of the frequency of radio signals received took place; for this purpose, a special radio apparatus and a recording chronograph were employed. In order to increase accuracy, measurements of the signals were taken on a frequency of 40 megacycles, a frequency least subject to influence from the ionosphere. The power of the transmitters insured certain reception of the signals over a field of direct visibility. Thus, in 24 hours it was possible to observe 6 to 7 consecutive passages of the satellite over land stations.

In order to process the radio signals received, the moment of the satellite's passage at the shortest distance from the observation point was defined with a tolerance of one-tenth to two-tenths of a second. The observations that have been carried out show that the Doppler effect can be used successfully to define the parameters of the satellites' orbit. The value of this method lies in the simplicity and reliability of the apparatus. With the rise of the frequency of the transmitter carried by the satellite, and with employment of schemes of automatic measuring of frequency, mistakes in this method can be substantially reduced.

For a more precise determination of the coordinates, special photographic theodolites (fotokinoteodolites) were used, and modernized aerial photography cameras were used for photographing the satellite's path. During the photography, the timing was set with the aid of a number of consecutive openings and closings of a shutter, involving the registration of the time of these operations by a photoelectric method. Thus, an interrupted trail of the satellite appeared on the photograph. Great accuracy was achieved in using these cameras.

Determination of the density of the atmosphere

Even before the launching of the first artificial satellites, the possibility of determining the density and temperature of the atmosphere through observation of their movements was noted. During movement through the earth's atmos-

phere, the artificial satellites met with resistance. The strength of the resistance is in proportion to the density of the atmosphere.

As a result of the breaking influence of the atmosphere, a gradual reduction in the height of the orbit of the satellite takes place. This continues until the satellite enters the dense layers of the atmosphere and ceases to exist.

The density of the atmosphere falls quickly, the further one gets away from the earth's surface, and the resistance force in different sectors of the elliptical orbit is not uniform. In a sufficiently extended orbit, the resistance force of the perigee is much greater than that of the apogee. Therefore, the main braking effect takes place in the perigee. This characteristic of intermittent braking means that reduction in height of apogee of the orbit takes place considerably faster than the reduction in the height of the perigee. The evolution of the satellite's extended orbit thus results in its form gradually becoming circular.

After launching of the first and second artificial satellites, optical observations and radio observation enabled the evolution of their orbits to be followed. On the basis of a theoretical analysis of results of these observations, it has been possible to determine these values as the product of atmospheric density times the square roots of the altitude of a homogeneous atmosphere, at the perigee altitudes of 225 to 228 kilometers of the first satellites.

On the basis of certain hypotheses on the height of the uniform atmosphere, the values (znacheniye) for the density have been calculated. The values obtained were 5 to 10 times greater than the values indicated for these heights, in a number of studies of the atmosphere based on rocket measurements prior to the launching of the satellites. It is worth noting that determination of the density of the atmosphere, and the study of purely mechanical influence of the atmosphere on the satellite are extremely accurate The atmosphere of the earth over different areas of its surface is not uniform. At the same height, the density and temperature changes according to the latitude and the time of day This is all related to the unequal heating of the upper atmosphere with ultraviolet, X-ray, and corpuscular radiation from the sun

As a result of the fact that the gravitational field of the earth differs from the central field, the orbits of the artificial satellites changed their situation in space. Thus, for the first satellites, the angular distance of the perigee from the midday meridian changed by approximately 4°, while the latitude of the perigee changed by 0.35° per 24 hours.

On the basis of data received, it would appear that the temperature of the atmosphere at heights around 225 kilometers is greater than previously supposed on the basis of theoretical considerations.

The discovery of the high temperature of the atmosphere confronts geophysicists with the problem of the sources of energy and its high heat capacity. The well-known "hard" ultraviolet and X-ray radiation from the sun will hardly suffice to explain this.

At present, it is possible to put forward hypotheses on this question. One could assume, for instance, that the upper layers of the atmosphere in polar areas are heated intensively by the corpuscular radiation from the sun. It is also possible that the entire upper atmosphere is receiving extra heat from either infrasound waves from the troposphere, or by electric current arising in the conductive ionized air as a result of its movement in the earth's magnetic field. The further study of the upper atmosphere with the aid of rockets and artificial earth satellites will make it possible to find a final answer to all these interesting and important questions

The results of research in the ionosphere

The observation of radio signals received from the first artificial earth satellites has provided new data on the outer part of the ionosphere—above 300 to 400 kilometers The ionosphere is the upper part of the atmosphere, consisting of a considerable number of free, charged particles, electrons and ions. When radio waves pass through the layers of ionosphere, the phenomena of their reflection, their partial and complete absorption, and the distortion of their routes occur. For this reason, radio methods have become the most effective means of carrying out research into the upper layers of the atmosphere.

In the reception of radio signals from the first artificial satellites on a frequency of 40 megacycles, it was possible in a number of cases to observe, free from distortion, the appearance and disappearance (radio-voskhod i radiozakhod) of the satellite's radio signals, and note the exact time. In contrast to the optical appearance and disappearance of the satellite, determined by the fact that the light rays pass to the observer from the satellite in a straight

line, in the case of radio appearance and disappearance, the radio rays are distorted in the ionosphere.

The data obtained from reception of radio signals from the first artificial earth satellites makes it possible to assume that the electron concentration in the other ionosphere, at a greater height than the main maximum, falls off with the altitude 5 to 6 times more slowly than it increases below the maximum. Thus in the 100-to 300- kilometer range, the electron concentration increased tenfold during the period of observation in October, while in the 300- to 500-kilometer range, it decreased twofold.

Research into cosmic rays

Two instruments registering the number of particles in radiation were installed in the second artificial earth satellite for the purpose of research into cosmic rays. In its flight around the earth, the satellite orbited at varying distances above its surface. Therefore, the measuring of cosmic rays on the satellite made it possible to define the independence of the number of particles on the height.

The data obtained have shown that from the minimal orbit height of 225 kilometers to a height of 700 kilometers, the intensity of cosmic radiation increased by about 40 percent. This increase was conditional, primarily on the circumstance that the greater the height, the less the shielding of the earth, the cosmic rays thus being able to reach the instrument from a greater number of different directions.

The earth's magnetic field also creates an obstacle in the way of cosmic rays reaching the earth. The study of cosmic rays with the aid of the apparatus installed on the satellite can also provide information on the dependence of the intensity of cosmic rays on latitude and longitude. This enables fresh information on the earth's magnetic field to be obtained. The measurement of the magnetic field over the earth's surface enables some picture of the character of the earth's magnetism to be formed, making it possible to forecast what kind of magnetic field should obtain at great distances from the earth.

In this way, it is possible to calculate the expected distribution of intensity of cosmic rays along the surface of the earth. In particular, it is possible to point out the lines of constant intensity of cosmic rays, the so-called isocosmic lines (izokosmy). The measurements of cosmic rays carried out during the flights of the satellite showed that the lines of constant intensity derived from the experiment and those calculated in theory, differ substantially.

This result is in accordance with the conclusions of the physicist Simpson, who arranged a large series of flights of high-altitude aircraft in equatorial areas. They showed that the equator found with the aid of cosmic rays does not coincide with the geomagnetic equator.

Consequently, there is a considerable difference between the characteristic of the earth magnetism—the magnetic field—obtained on the one side with the aid of cosmic rays, and those obtained by means of measurement of the magnetic field on the surface of the earth

These differences are explained by the fact that the trajectories of the movement of cosmic rays are determined by the magnetic field at very high altitudes, while the direct measurements give characteristics of the magnetic field near the surface of the earth. Cosmic rays permit probing of the magnetic field at great distances from the surface of the earth, giving an opportunity for a new approach to the study of the magnietic field of the earth and the system of electric currents in the upper layers of the atmosphere.

The observation of cosmic rays by the earth satellite made it possible to register the fluctuations of the intensity of radiation. These variations are evidently connected with the state of interplanetary space near the earth. One case of a sharp increase—50 percent—in the number of the particles of cosmic radiation was registered. At the same time, the ground stations did not discover at that time any substantial increase in the intensity of cosmic radiation. This event is now being studied in detail. It is thought that it was due to generation in the sun of particles of low-energy cosmic rays, which are strongly absorbed by the earth atmosphere, or due to the earth satellite passing through a stream of electrons of high energy connected with the corpuscular radiation of the sun. These phenomenums could not so far be registered, because the instruments for the (word indistinct) observation of cosmic rays were situated on the surface of the earth. The artificial earth satellites have for the first time allowed full research to be carried out in primary cosmic radiation.

Biological research

It was possible to carry out a biological experiment under cosmic flight conditions only in an artificial earth satellite. First of all it dealt with the study of the effects on a living organism of a prolonged condition of weightlessness, primary cosmic radiation, certain types of solar radiation and other factors. The data obtained when the program of medical and biological research was carried out in the second artificial earth satellite is of great value.

As is well known, the dog, Laika, took a cosmic flight in the satellite. Of great interest is the behavior and the state of the animal during the most difficult stage of the flight of the satellite from the biological point of view—in the time of its launching and its going into the orbit. The movement of the satellite while it was being placed in orbit was accelerated, and the ratio of acceleration exceeded by many times the force of gravity on the surface of the earth. At the same, the apparent weight increased in proportion to the increase in acceleration.

During the time the satellite was going into orbit, the position of the animal in the satellite was such as to experience the effect of acceleration from the breast to the back, and in this case the force of the acceleration pressed the animal to the floor of the cabin. This position of the animal was chosen because it was one of the most convenient for living organs. While the satellite was being brought into orbit, the animal was affected by vibration and noise of the engine of the rocket, in addition to the effects of acceleration. The behavior and the state of the animal during the period of time that the satellite was brought into the orbit were adequately recorded.

From information obtained, it is possible to establish that up to a certain increase in acceleration the animal stood up to the seeming increase in the weight of its body and kept the freedom of movement of its head and trunk. Then it found itself pressed against the floor of the cabin, and there were no noticeable movements recorded. The decoding of the data received from the satellite show that immediately after the start the rate of heart contractions increased approximately threefold. The analysis of the biocurrents of the heart on the electrocardiogram did not reveal any signs of ill effects, giving only a typical picture of the speeding up of palpitations, the so-called sinus tachycardia.

Later, when the effect of acceleration not only continued but grew stronger, the speed of heart beats decreased. It is easy to imagine that in accord with the increase in the apparent weight of the animal the breathing motion of the thorax became more difficult. Breathing became more shallow and frequent. In fact, the recordings of the telemetric signals have shown that when the satellite was brought into orbit the frequency of the breathing of the animal exceeded the original by 3 or 4 times.

There are grounds for believing that the changes noted in the state of the physiological functions of the animal were due to a sudden effect of sufficiently strong outside irritants on the organism—the acceleration, noise, and vibration which began during the start and continued during the period of the satellite's coming into orbit. Analysis and comparison of data obtained with the results of previous laboratory experiments permits the assertion that the animal endured quite satisfactorily the flight from the start of the satellite until it was brought into orbit.

After the satellite went into orbit, the centrifugal force which acted on the satellite had balanced the force of gravity of earth, and the state of weightlessness came into being.

There, the body of the animal stopped pressing against the floor of the cabin, and owing to contraction of the muscles of the extremities, was easily pushed away from it. Judging by the available recordings, these movements were not of very long duration, and sufficiently smooth. In connection with the fact that the thorax of the animal did not experience any more pressure under the influence of an increased weight, the frequency of breathing decreased.

After a very short period of increased palpitations, the frequency of the heartbeat continued to decrease, and to approach normal. However, the period of time during which the heartbeats reached their normal level proved to be approximately three times longer than the period in laboratory experiments, when the animals were subjected to the effects of the same accelerations as those when the satellite was sent into orbit. This is probably due to the fact that after the effect of acceleration had ceased, the animal, during the tests made on the ground, found itself in normal conditions, while in the satellite the accelerated motion changed into a condition of complete weightlessness.

In conditions of weightlessness, sensitive nervous centers of the animal which signal the position of the body were not sufficiently affected by external irritants. This caused fluctuations in the functional state of the nervous system which regulates breathing and blood circulation, and was responsible for the somewhat longer period that these functions took to return to normal again after acceleration had ceased.

The normalization of functional indexes of blood circulation and breathing in a state of weightlessness—during the satellite's revolutions in the orbit—however, by no means prove that this factor failed to cause any substantial and lasting changes in the state of physiological functions of the animal. One can thus say that not only during the satellite's being placed in orbit, but also in the course of its movement along the orbit, the animal behaved satisfactorily.

It was, however, impossible to form any definite idea of the effect of cosmic radiation on the test animal. No obvious physiological effect was directly observed. In order to carry out detailed research into this question, it is essential to observe the animal for a long period after the flight. This will be done in further experiments. The first assessment of the results obtained clearly shows that animals behave satisfactorily in the conditions of cosmic flight. In this light, the positive results of the experiment make it possible to continue and expand research aimed at safeguarding the health and life of man in cosmic flight.

The study is continuing of the large body of scientific evidence obtained with the first Soviet artificial earth satellites, both in the course of experiments described in this article and in other experiments carried out with the aid of the first satellites. Further launchings of satellites during the International Geophysical Year will make it possible to extend the scope of most important scientific experiments carried out in outer space, and to gain greater insight into a series of processes taking place in the upper layer of the atmosphere and in the cosmos.

(Editor's Note: TASS, Russian, at 0258 GMT, April 27, summarizes the article and adds that "preliminary results will be published in the near future in the form of scientific articles in different magazines.")

"Stationary" Satellites

Moscow, TASS, Radioteletype in Russian to Europe, April 23, 1958, 2207 GMT—L.

(Text) Kiev—The launching of an "immobile" earth satellite is a possibility, according to Nikolay Barabashov, a member of the Ukrainian Academy of Sciences in the Rabochaya Gazeta. The term "immobile," the academician writes, is not quite exact; it would be more correct to call it "stationary."

The stationary satellite can be created by launching into interplanetary space over the equator a body which, after having gone into the orbit, will move from west to east with a speed equal to the angular speed of the revolution of the earth around its axis. As a result of such launching, the satellite will always stay above a definite point of the earth's surface. The linear speed of the flight of the satellite must equal 3,076 meters per second. It has been calculated that it must stay at a height of 35,000 kilometers above the equator.

It is possible, the scientist continues, that when a certain level of development of stratoaviation is reached, the stationary satellite launched into stellar space may be used as a changing post, to which it will be possible to fly at any time without waiting for it to take up a definite position in relation to the flying field on earth. By launching three stationary satellites and placing them at distances of 120 degrees from each other along the orbit, it will be possible to observe the entire globe except for the polar zones, because the satellites will be placed in the plane of the equator.

Mr. Hays. I would like to ask you about the situation with reference to other nations, including the Iron Curtain countries. What do you know about the activities in Red China, for example, in this field?

Dr. Berkner. We know relatively little about the activities of Red China. We have some information which indicates that they are entering into a program of observing the Soviet satellites in cooperation with the Soviet scientists.

The Red Chinese originally adhered to the International Geophysical Year. Then for political reasons, probably because of the adherence of the Nationalist Chinese to the IGY, the Red Chinese decided to withdraw.

They are the only nation which has withdrawn for political reasons. All other nations have laid politics aside on the grounds that adherence to genuine scientific enterprise should have no political implication of any kind.

Mr. HAYS. Then in the free world association of scientists you have, perhaps, complete congeniality and free discussion. Is that correct?

Dr. BERKNER. That is correct, and to a substantial extent with respect to the Soviet Union and to the Soviet satellite states.

I think the discussion of unclassified scientific information has been rather full and complete with all nations excepting only Communist China.

Mr. HAYS. Mr. Durant got down to specifics on the United States taking a lead in the establishment of an international agency in this field. I assume you share his views. The tone of your statement would indicate you are in full accord with him.

Dr. BERKNER. We might debate the detailed character of such an agency, but I do not think that is important at this time.

The objective is one on which we certainly agree. It is quite evident that only a few nations, perhaps only two, the United States and the Soviet Union, can afford to enter into operations in space. It is clear that there will be great frustration on the part of individual scientists of other countries if they find it impossible because of their nationality to enter into some sort of space activity.

We certainly have much to benefit by encouraging such scientists to join into our activities.

Mr. DURANT. I am pleased to have Dr. Berkner's support on my suggested program. The method of implementation is secondary.

Mr. HAYS. Do you share his views that the cost will be insuperable without some help from other nations?

Dr. BERKNER. I do not believe the cost will be insuperable without help, but it would be less and, of course, we are all taxpayers.

Mr. HAYS. I do not recall he said they were insuperable, but you do share his concern about the cost of an adequate and comprehensive space program?

Dr. BERKNER. Yes. Certainly one can look at this two ways. Either the cost of a given program can be substantially reduced by accepting the cooperation of our fellow scientists in other countries, or to look at it on the other side of the coin, it will be possible to do much more space research than would be possible by trying to do it alone.

Mr. DURANT. I believe, Mr. Hays, that the term "insuperable" is not correct. I did refer in my closing statement to the fact that at some time in the future long-range, large-scale astronautical exploration will take place. At that time the costs of such programs probably could not be supported by one nation. From the standpoint of efficiency international cooperation would be highly desirable.

However, in the meantime, cooperation with tracking stations in scientific research can be done.

Mr. HAYS. We will use the words "substantial cost."

Mr. DURANT. Very good, sir.

Mr. HAYS. I would like to ask you both to comment on this:

I was in Moscow last week. While I gathered no information in this field that is not available to the general reader of documents coming out of Russia, I was interested in a side comment by one of the Russians as we passed a very imposing building. It was evident there was great pride in the fact that this building was one of their academies of science and the Russian added proudly, "We have several."

There is no question, is there, about the great interest being taken in the Soviet Union in this field?

Dr. BERKNER. There is no doubt about this, Mr. Hays. We must remember that the very foundation of Marxist ideology rests on the belief that science, and the materialism emerging from science, exploited by a Marxist government, would bring about the results for which they hope.

Therefore, from the very beginning of the present Soviet regime they have put tremendous emphasis on science. This is now beginning to pay off. This year, I believe, they passed us in the total number of scientists and engineers active in the Soviet Union. As nearly as we can estimate, these men are very well trained, extremely capable men in every sense.

Mr. DURANT. I concur with Dr. Berkner's views.

Mr. HAYS. Of course, we in the free world have a valid point in reply to that in this international competition, namely, that it is at expense of moral and spiritual values.

In other words, in applying our judgment of value to the Soviet world, we are saying that this great divergence of interest and this neglect of the moral and spiritual values has brought them that advancement at great cost. That is a philosophical observation.

Dr. BERKNER. Yes, Mr. Hays. I think our attitude among American scientists would be that an equivalent effort in the field of science will be necessary to maintain our position in the world competition. But that this certainly can and must be done with the full recognition of the other values that Americans hold highly—freedom, the spiritual values, the moral values, the ethical values—values that western culture generally regards very highly.

Mr. DURANT. I concur with Dr. Berkner.

Mr. HAYS. I have never detected in the disciplines of the American scientists, and I am speaking of physical scientists, any other feeling than that, that our progress in the field of science, physical science, must be matched by a comparable appreciation of the purpose of life and the purpose of discovering truth.

I mention this not because anyone needs convincing, but in the record it seems to me it should bear reiteration that our excitement over the great new field of endeavor is not to overshadow our appreciation of these basic purposes of life.

Dr. BERKNER. This is certainly something to which all Americans could subscribe.

I might add that I would hope and believe that the satellite and space exploration generally adds not only to our technical knowledge, but will add considerably to our philosophy, art, literature, poetry, humor, and to appreciation of human endeavor generally.

I see that my old friend, Mr. Fulton, is reading a book on exploration of space by Clarke which incidentally was written in 1951. It still is an entertaining and useful book on this subject.

Mr. FULTON. I hope that our perspicacity that you commented on in this committee equals your perspicuity.

Mr. HAYS (presiding). Mr. Natcher.

Mr. NATCHER. The bill before the committee establishes and creates a National Astronautics and Space Agency. Under the provisions of this bill we have a Board of not to exceed 17 members. The Director is to be named by the President and confirmed by the Senate.

There are a number of other important provisions in this bill.

What suggestions do you gentlemen have concerning any matter or any portion of the bill that should be changed in order that we can carry out the purpose that we have in mind?

Dr. BERKNER. Mr. Natcher, I have given the matter of organization a great deal of thought in preparing this testimony. It seems to me that we must remember that the Agency will be primarily concerned with research.

The operations that it conducts will be operations which are conducted primarily in support of research.

Therefore, I have asked myself the question whether I thought a commission form of administration, such as that of the Atomic Energy Commission, or the present Board-Director type of operation, such as that now used in the NACA, would be best.

First of all, it is my feeling that if the Agency becomes ingrown—primarily a monopolistic type of Government agency—the United States would lose very badly by such arrangement. It is quite clear, from experience gained from our present satellite programs, that science from universities, from industry, and from American institutions generally, must join with the Space Agency if its operations are to be effective.

I would very much doubt that one could ever assemble a sufficient staff within the agency to be competent to carry out all the research needed to keep America on the forefront of space science.

Therefore, I reach the opinion that in order to maintain close contact with what I would call the academic side of space activity, so that we can reach the scientists and the engineers and the men who are most likely to contribute most creatively to our progress in space, that it would be best to have an advisory board of the kind we have in the National Science Foundation, for example, with a strong director, very similar to the present form of administration in either the Science Foundation or the National Advisory Committee for Aeronautics.

Mr. NATCHER. Mr. Chairman, at this point I yield to Mr. Feldman.

Mr. FELDMAN. I just wanted to clarify something. Dr. Berkner, under the administration proposal the Board itself becomes an advisory board where previously it was the executive board. Now, the only thing it can do is advise. The Director does not have to take that advice.

Would that, in any way, modify your last answer?

Dr. BERKNER. I rather think that a wise Director, one which would be confirmed by the Senate, would be a man who would heed the advice of the Board very carefully. One would suspect that if there were sharp differences of opinion between the Board and the Director that these would be examined most carefully.

On the whole, from a policy point of view, I prefer to see the type of organization that we traditionally have in American industry and

in American education over which one has, if you like, a board of trustees and a president or managing director.

Mr. FELDMAN. Would you make that Director a member of the Security Council?

Mr. BERKNER. I would leave this, I believe, to the discretion of the President.

Mr. NATCHER. Am I to understand that you gentlemen agree with section 4 of the bill providing for a Board of not to exceed 17 members? Do you agree that that type of setup in this particular legislation is proper?

Dr. BERKNER. I would recommend it, sir, as proper.

Mr. NATCHER. Do you both agree?

Mr. DURANT. I do not believe I would object, in principle, to the way this is written at this time. If I might interject one thing here, I think it has been clearly brought out that the all-important person is the Director and if he is a wise man, a knowledgeable man, he will draw from wherever he can find strength and technical competence in this country.

Mr. NATCHER. I would like to have you describe to the committee the type of man that the Director should be. What should be his qualifications? If you selected him, what type of individual would you select?

I have this in mind, and I would like you to start with this premise. Should he first be a scientist? Should he be a man with a lot of administrative ability, with proven qualities? What type should he be? How do you feel about it?

Dr. BERKNER. In my opinion, Mr. Natcher, he must be a scientist because the major decisions he must make involve the evaluation of the recommendations of subordinates concerning matter of scientific research and engineering.

In addition, he must also be an administrator. After all, we have in the United States at the present time a very substantial number of men with excellent scientific training, many of whom have made original contributions, who also are proven administrators. I am sure that such men will be found.

Mr. NATCHER. Now, I would like to hear from you, Mr. Durant.

Mr. DURANT. The only other point I would make, before I comment upon the type of person required as Director, is my opinion that in whatever way the bill is written, the Director, if he is the right man, will draw from the strength of this country with respect to those rocket research and development teams which have a sound record of achievement. There are also many individuals who have distinguished themselves over the past 5 or 10 years, who have worked very hard in studies, mostly on their own time, and at considerable personal effort and risk to their own reputation. These individuals have worked hard and contributed greatly to the science and technologies of space flight. These teams and individuals, somehow, must be used in any national space flight program.

I presume that when any United States space agency evolves that rather than building up a tremendous colossus, which within itself would perform all space flight research, development, and production, that much of the work would be contracted to individual teams no matter where they are, whether they are in industry or are in various arms of the services.

For instance, we have a powerful team at Huntsville, Ala., we have another one at the Naval Research Laboratory, and others in the aircraft and missile industries. I hope sincerely that these people will have the opportunity to contribute in this work.

Now in regard to the director of a national Space Agency, it seems to me that we need a strong voice at the top, a civilian—without doubt a scientist—and one who has a distinguished record not only in administration but also in knowledgeability of the subject he is about to direct. You cannot learn the business of space flight overnight. One of the major reasons why many of the former German nationals are so competent is the 10 to 15 years head start on our scientists and engineers in thinking on and working on rocket developments.

The CHAIRMAN. Above all, he has to have the respect of the scientific community.

Mr. DURANT. The respect of the scientific community and also, I believe, the technical people, the engineering community which will be involved.

The CHAIRMAN. I meant to include them. He does not necessarily have to be a scientist, but the fact that he is a scientist should not bar him?

Mr. DURANT. No. I think, undoubtedly, he would be a scientist, one who has had a significant amount of academic training.

The CHAIRMAN. Is Dr. Killian a scientist?

Mr. DURANT. I think he is a scientist.

The CHAIRMAN. He testified he is not.

Mr. DURANT. I think it is a matter of education and training. One can substitute years of responsible work and achievement for some academic training.

The CHAIRMAN. Is it not hard to locate in this field the administrators that have the respect of all elements that make up the activities, particularly in the scientific field?

Mr. DURANT. I would like to suggest, for example, that Dr. Wernher von Braun is not generally considered a scientist, yet he has a doctor's degree and has outstanding proven experience. In the final analysis you come down to the man himself. It is imperative that the qualities of leadership, enthusiasm, and humility backed by sound experience and a successful professional record.

The position of space agency director will carry a tremendous responsibility. Whoever is chosen, the results of his endeavors, in the next few years will affect the future strength of this country in a most vital way.

The CHAIRMAN. If the director form of agency is decided upon, the sum and substance of the testimony of both of you is that the President should be very, very careful in his selection?

Mr. DURANT. Indeed, sir.

The CHAIRMAN. Do you agree to that, Admiral?

Dr. BERKNER. Yes.

Mr. NATCHER. Gentlemen, what suggestions do either of you have that will be of benefit to the committee in strengthening this bill and putting it in better shape? Do either of you have suggestions?

Dr. BERKNER. I would say, Mr. Natcher, that in my opinion the bill is in fairly good shape at the present time. Now, I have had no legal training and there may be many of you who can turn a legal

mind to the bill and can see language that must be clarified to make its intent unambiguous.

The CHAIRMAN. For example, the bill states: "The Congress further declares that such activities should be directed by a civilian agency * * *." "Should" is a kind of cloudy word. Should it not be "shall be"?

Then there is the question of the liaison committee between this agency and the Defense Department and the AEC which is not provided for. There is a question of what position will the Congress take in connection with a committee, joint or otherwise. There is nothing on patents in here protecting the Government.

Of course, we do not expect you gentlemen to have knowledge of all those aspects. Of course, some individual largely drafted this bill. We know who drafted it and he did a pretty good job, sufficiently so that I introduced it.

Ordinarily, if I did not agree with the bill, as chairman of the committee I would put the words "upon request" on it, but I did not do so. I think the bill provides a very good basis for the committee's consideration.

So there are many improvements here that can be made although the bill is a good basis to act upon.

Dr. BERKNER. I must say with respect to your comment on the joint committee that I have always had a great admiration for the effectiveness of the Joint Committee on Atomic Energy of the Congress, and particularly the searching studies of my old friend, Senator Anderson.

The CHAIRMAN. He is a House-trained member, you know.

Dr. BERKNER. So I recall. Certainly, this committee has demonstrated one thing for atomic energy in the legislative branch because of its joint character that would be very valuable if carried over into the space work; that is, because of its joint character, the committee has been able to devote a great deal of time and effort to the single hearings. It has covered very much ground of a kind which I think the Congress has a right and duty to cover. The same kind of thorough studies should be covered with respect to the Space Agency by Congress.

I think it would be certainly worth your careful consideration to think in terms of a joint congressional committee for this important future activity.

The CHAIRMAN. I refer to these because we have them in mind, but there may be some suggestions from the scientific angle that you gentlemen might make.

For example, you might consider the declaration of policy, whether it is broad enough, whether it states the intent of Congress. That has great importance. I would level on that.

And from the scientific field I, as one member, would like to get some opinion, not confining it to the declaration of policy, but I would suggest that interested parties in the scientific field level on that declaration of policy and transmit their suggestions to us.

Mr. DURANT. The declaration of policy is really very well written. I would turn to item 6 of the declaration of policy. I would assume that this permits the cooperation of this agency with the scientists of other nations as well as those of the United States.

The CHAIRMAN. You may be right, cooperation of the other nations or groups of nations. That means on the level of nations, not

individuals. Both of you have stressed that. That is just one illustration where I think the intent is to improve that.

But suppose that language is in the bill and it becomes law and you are the director or administrator—I think director is too limited a term for this important activity. The thought enters my mind, I noticed that before, would that allow them to engage in the exchange of information, talks, and so forth with individuals or groups within nations? That is something to think about.

Mr. DURANT. Mr. McCormack, I think you very clearly pointed out something that I did have checked here also. I feel this might be amended to say "or organizations within these nations as appropriate." But I think, coming back to the bill itself and with respect to the policy as stated, it is well written and I think there will be opportunity for amendments and clarifications later on.

But with the proper director and with the spirit of the bill—the spirit is excellent—I believe that these matters will sort themselves out. I think you are quite right with respect to discussions only at the national level, we will not accomplish what Dr. Berkner and I hope will result from the future cooperation of scientists and groups of scientists on an international basis.

The CHAIRMAN. I asked the question only in connection with my original suggestion that you gentlemen and others in the scientific community make suggestions to the committee. I hope it will be soon, because we are going into executive session in the not remote future.

This committee as you know has taken the lead. We have been devoting our time 5 days a week, which is unusual, morning and afternoon, and all these members are all members of other important committees and I happen to be a majority leader, yet I am very proud of this committee, their devotion to their duty, their mission, their task.

We have been devoting our time and it is important to get any suggestions within the reasonably near future because we are going into executive session for the purpose of writing a bill some time after May 7.

Dr. BERKNER. Mr. Chairman, in the declaration I would take a look at one more point, point No. 7, which says:

> The most effective utilization of the scientific and engineering resources of the United States and the avoidance of duplication of facilities and equipment.

One must read these words very carefully to determine whether this means the Agency feels itself obliged, under the definition of policy, to accept the participation of scientists in the universities and institutions where many of the greatest skills for space research will be found.

You will note in my testimony on page 3, I emphasized the point that this language should permit any qualified scientists to plan and prepare a useful space experiment at his university or in his laboratory with the expectation of getting it into space with the cooperation of space agencies, of course within the restrictions of the funds and technology available.

I think this is very important because one would hate to see a Government monopoly set up in this Agency; I would assume that the legislation should be quite clear on this point.

The CHAIRMAN. In other words, you think we should say something about the power to make contracts?

Dr. BERKNER. Certainly to encourage the Agency to cooperate with American science generally in the achievement of its objectives.

The CHAIRMAN. I think that is the intent.

Mr. DURANT. Mr. McCormack, turning to line 23, page 2, item 6, "Cooperation by the United States with other," and then if it was "appropriate organizations and individuals of all nations and groups of nations," some wording of this sort would indicate that it would be possible and desirable.

The CHAIRMAN. That could be worked out. Level on it and give us your suggestions.

Mr. DURANT. Again on item 7 where it talks about the avoidance of duplication, I think it is the standard military phraseology in bills to say "avoidance of unnecessary duplication," because again it is sometimes desirable and prudent to have parallel programs in important developmental work.

The CHAIRMAN. I would think this is more in respect to governmental technical avoidance of duplication of facilities and equipment. That is a very desirable objective.

Mr. DURANT. Yes, sir, but it does not necessarily mean any necessary duplication would be improper.

The CHAIRMAN. Again you have to apply the rule of reason.

Mr. DURANT. Correct. This, then, comes back to the director.

The CHAIRMAN. And it comes back to the matter of administration. You cannot write every little thing. If you wrote every detail, you would put a man in a straitjacket. You have to have some confidence in those who administer it. I have, until it is proven to the contrary.

Mr. Natcher.

Mr. NATCHER. Mr. Durant, I would like to direct this question to you. The Soviet Union has a crash program underway at the present time in the missile and satellite field. How do you feel about a crash program in this country after enactment of this legislation?

Mr. DURANT. Mr. Natcher, that is a loaded question. I think the problem is one really of defining what you mean by "crash program."

Mr. NATCHER. Let us put it on this basis, Mr. Durant: Should our program be speeded up considerably from the program that is now underway? Let us start there.

Mr. DURANT. I would certainly answer that question in the affirmative. In fact, I might comment that our efforts have been rather slowed down on a national basis during the past 6 months while awaiting action upon such a bill such as you are considering and authority and funds to go ahead with space-flight research.

The military, particularly the Air Research and Development Command, and the Army Ballistic Missile Agency and the Naval Research Laboratory, all have advanced projects which are awaiting approval. Likewise, industry has worked up proposals for substantial space-flight programs.

Now, it is going to take a while for this proposed organization to get underway and I certainly presume that the Advanced Research Projects Agency (ARPA) will continue in being and given authority and funds to go ahead for the time being.

However, I do not like the term "crash program" because unless you know exactly where you are going to go, as we did in the atomic energy work during the war, which was a crash program, I do not believe that such a program is desirable until it is known clearly who

is going to administer the program. It should then be funded on a long-range basis. At that time full speed could, and should, be applied.

I believe that space research is of tremendous importance to the future of this country. To that end I believe that due recognition of this should be given by the highest levels in the country, with communication to the President, and certainly with the National Security Council. I am convinced that such action will be approved by the citizens of this country.

Mr. NATCHER. Thank you very much.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. I am glad to have you gentlemen here and I think you have contributed a great deal to the development of this science and to this committee.

My question first comes up, how should we in the United States approach space? Shall we do it in the context of a race with Russia, or shall we do it on our own under a national policy that is instrumented by a national space agency?

I happen to be the Republican side at this point, but I make up in interest what I lack in numbers.

Dr. BERKNER. In my opinion, Mr. Fulton, we cannot ignore the effort that Russia is making in this field in the establishment of any program.

Mr. DURANT. I concur with Dr. Berkner.

Mr. FULTON. So in relation to Mr. Natcher's question, you would speed up our programs, broaden them on many fronts, and continue basic research and study, as well as an implementation program?

Dr. BERKNER. I would say it like this:

I think if we were to try to match their achievements one by one, we probably always would lag.

It seems to me we must set up a program looking to a reasonable distance in the future, perhaps 5 years, programing our effort so that we will have a reasonable expectation of staying parallel with them in most fields and ahead of them in some.

Mr. FULTON. So that we choose our own course rather than always try to match and be a close second.

Dr. BERKNER. Yes, sir.

Mr. FULTON. Would you comment, Mr. Durant?

Mr. DURANT. Mr. Fulton, I think that whenever this bill, in some form, is authorized or someone is given the authority to go ahead and plan and program space research, the first action should be to stop for a month or 2, and for the key individuals to study and decide upon; first, a short-range program, which would be on the order of 2 to 5 years, and secondly, a longer range program, 5 to 10 years.

I believe that the Agency's programs inherently should be drafted with confidence, show initiative, and a certain boldness.

As Dr. Kantrowitz has suggested, "a spirit of adventure" should be built into the planning and administration of the United States program.

Such an approach does not necessarily mean extraordinary cost. On the contrary, a bold program will result in more rapid advancement and greater scientific benefits in the long run.

I think that the suggestion of the "plateaus of capability" made by Mr. Ehricke are really significant. These plateaus of capability in-

clude within each "plateau" the ability to carry out many research projects. The decision to conduct a particular project may be decided upon at a later date in the light of subsequent events.

We certainly do not want to, in fact could not afford to, perform all of these various projects that have been suggested to date. There have been some very, very poor suggestions put forward publicly to date, in addition to some very fine programs.

If we attempt to match the Soviets or if we attempt merely to do spectacular things without a clear appreciation of the scientific and technical potential, then we are going to lag in the race. And it is a race; we will be, in the vernacular, in the Russian rocket exhaust for the indefinite future if we do attempt simply to match their accomplishments.

The U. S. S. R. commission on astronautics has a program, they have authority and funds, they are in motion.

In the case of the United States, we are still trying to get into motion.

Mr. FULTON. Your comments as a scientist have interested me because the question then comes up, what happened in science in Russia historically?

For example, in 1927 it was Tupelov who said that the Lenin method of scientific concentration and centralized control should be dispensed with.

So in 1927 the Russians changed their system and got decentralized science. Likewise, they moved it from one person into a vice minister who is on the Council of Ministers and then put the Academy of Sciences separately under a science secretary who is really not political, but largely scientific. Is that not right?

Mr. DURANT. From my understanding of the organization of the U. S. S. R. Academy of Sciences, you are correct.

Mr. FULTON. The question comes up when you in your statements have been complimenting the Russians on their fast progress. As a matter of fact, in the statement of Mr. Durant, he says in the second paragraph regarding the Commission on Astronautics, Academy of Sciences, U. S. S. R.:

> This body had the responsibility to organize the program, to assign the appropriate research tasks and to see that this work was carried out. Their job was to identify the basic problems which had to be answered before scientific research could be launched, and obtain the answers. They were eminently successful.

Now, remarkably that is a specific recommendation for a commission type of approach to the astronautics and aeronautics field because it has worked for the Russians.

Actually, it has done better, in some minds, than the United States has been able to do.

Now, my question is this: If the tried and proven methods that have been used have resulted in an eminently successful result in Russia in this very field and likewise when the tried and true commission form has been used on the Atomic Energy Commission, why should not this committee in recommending policy to the Congress and the country recommend a commission form of five members?

My point is this: Instead of having one man who is in charge, as General Groves was in the Manhattan project, which we quickly left in the United States and then moved over to a civilian agency,

why do we not in the aeronautics field start originally with a civilian agency that has the primary responsibility of making a national space policy for the United States overall? Why do we not just start with that?

Dr. BERKNER. Mr. Fulton, was it not true that the Soviet Union used a single overall director for its planning for the satellite project? That was General Blagonavov, starting in 1950.

Mr. FULTON. May I comment on that?

On the matter of implementation I would assume, when it comes to specific programs, they should have personal direction.

For example, on this Commission I would probably put as the Chairman of it Dr. DuBridge, the president of the University of Cal Tech. I would put on a man in charge of nuclear and atomic research, and to conform it to space use, a man like Admiral Rickover.

I would put on, maybe a person who is interested in the far reaches of development, a man like Admiral Hayward, head of research and development in the Navy.

Likewise, because the good Dr. Dryden has been head of the NACA and has done an excellent job in aeronautics, I might put him on the job as an aeronautics member.

Mr. DURANT. Mr. Fulton, might I suggest that you might also have as a representative in such a commission a space medical man?

Mr. FULTON. My other recommendation would be a person who has a military background, but who is a civilian, and that would be Dr. York, head of ARPA, the agency for advanced research programs.

If we did that we would be doing something like Russia has done because on the Committee on Astronautics right now there is, first, a man who is a straight military man, an ordnance representative and secondly, a man who is one of their academy men, more of a professional type, but interested in the military. Is that not right?

Dr. BERKNER. Mr. Fulton, I would be very much afraid of this organization. I am sure it would have great brains, but it could not possibly have the singular purpose of the kind that was deliberately used by the Soviet Union in directing their present program.

We must remember that our program lagged, not because we had a single director (which we didn't) but because we were slow in organizing our rocket research. Starting way back in the 1950's and running right down to 1955, when we were told to go ahead with the satellite program, there had been two serious breaks in our rocket program.

Mr. FULTON. Were you scientists not at fault, because my interest began in 1945 and I have been interested ever since? Were you not at fault in not trying to stir up public opinion in this country to back you on a broader basis, and, secondly, were you not at fault in not telling us that the Russians were aiming at a faster program than we were and were going to outstrip us?

Dr. BERKNER. I suppose we tried to do this. I think we might find statements to the point. Because we did not have the kind of agency we are discussing now, there was no one to defend the two great cuts that took place. I think these are equally distributed, one under the Republican and one under the Democratic Congress in the Naval Research Laboratory program, which is the direct antecedent to the present Vanguard program.

Mr. FULTON. I might add that I voted against all cuts, straight through, in the military research program.

Dr. BERKNER. My point is the following: That our delay in getting the Vanguards up, I think, if it can be traced to anything, was the general slowness of getting started on our rocket program generally.

Mr. FULTON. Were we not trying to instrument too much when the Russians were just going to shoot a cannonball out of a cannon? We were trying to put on an instrument for solar energy and to go ahead with it as a project under the International Geophysical Year, while the Russians suddenly decided they would get ahead of us.

Dr. BERKNER. It is my view, if you will read this announcement of their scientific accomplishments, that they were pretty well instrumented. I think we would have looked very foolish, indeed, just to shoot a ball out of a cannon without trying to do the scientific job. I think that the intellectual people in the world are a bit too sharp to be taken in by the mere propaganda of having a shot landing on the moon with a great big splash, but with no scientific meaning.

Mr. FULTON. There was opinion in the United States that we were doing a lot of research. We in August 1957 had the Russians come here and visit our facilities and talk with our scientists on the earth-satellite program. Then there is a feeling in many quarters that it was like the canary that jumps on the eagle's back. When the eagle flies high as it can and then just as it reaches the top the canary jumps 30 feet higher and it has the record.

Dr. BERKNER. Certainly at that time we did not anticipate the dates of launchings of the Soviet satellite.

The thing that held up our program was not the scientific work that was done on our satellites, but it was the rockets. Now, just yesterday there was another failure of the rockets. Every satellite that we have been able to put in orbit has worked successfully from the very beginning in the scientific sense.

So the difficulties that we had did not stem from the work that we have done on the scientific side of the satellite program. Certainly every bit of this work was justified.

But our failures have come from our failures in making good rockets.

Mr. DURANT. I merely want to concur very strongly with Dr. Berkner. First, for the record, if I might comment on the Commission on Astronautics of the U. S. S. R. and the suggestion that we might follow a similar commission in this country.

Mr. FULTON. No, not a similar commission; our own type, such as the Atomic Energy Commission.

Mr. DURANT. I think we should examine that from the point of view of how well it worked with AEC, not with respect to how well it worked in the U. S. S. R.——

Mr. FULTON. I think we should be openminded and look at both. Here we have two tremendous advances made by the commission type, one the AEC in this country, the other the commission in Russia, under the Academy of Sciences.

Mr. DURANT. One reason they did accomplish so much, of course, is that they got off to an earlier start.

Mr. FULTON. What is wrong with the commission form in this country? What do you see as the defect?

Mr. DURANT. I believe that either would work. It is a matter of the spirit with which it is gone about.

Mr. FULTON. May I ask Dr. Berkner that?

Dr. BERKNER. I will point out that the great advances in this country, which first started with atomic energy, took place under a single direction. We must remember that the major advances, the proving out of atomic energy both in reactors and in nuclear weapons took place when General Groves was the czar, if you like, of the program.

Likewise, I would point out only this week in the journal Science that Mr. Ginsberg made the remark that under the direction of Dr. DuBridge, who was the single director of the radiation laboratory at MIT during the war, 50 years work was done on radar in 5 years. That is the kind of progress we need in space research and exploration.

Mr. FULTON. That is why I have recommended Dr. DuBridge as the chairman because he not only has had previous experience and has compressed tremendous research into a short time, but he has organizing and administrative ability and has administered the university pretty well. Besides, he can raise money.

Mr. DURANT. Mr. Fulton, I think you mentioned something about the extremely complex instrumentation of our Vanguard program. As Dr. Berkner pointed out, this did not affect in any way our launching dates. The launching dates of the Vanguard program itself, its troubles, have been completely concerned solely with launching vehicle reliability. Since I had some connection originally with the Orbiter program, I feel strongly about this.

Mr. FULTON. The members of the Astronautics Federation are all free countries, except the U. S. S. R., Poland, and Yugoslavia?

Mr. DURANT. Those are the Communist countries represented by member societies of the IAF.

Mr. FULTON. In the International Astronautical Federation, did they deal with other coutries as units, as if they were delegations, by country, or did they divide off by scientists and disagree among each other, even though they were from the same nation?

Mr. DURANT. As individuals, sir.

Mr. FULTON. Do you agree on that?

Dr. BERKNER. Yes; very much so.

Mr. FULTON. Let us ask about the International Geophysical Year, as to how it was handled there. It is not clear from the statements whether these scientists were disagreeing among themselves or were acting as country teams. On your meetings with them at the various conferences and in this country, did they deal, for example, as Soviet teams, or did they disagree among themselves?

Dr. BERKNER. Both. If purely scientific matters were under discussion, one always dealt person to person, one scientist to another.

However, in the International Geophysical Year there was involved the commitment on the part of each nation for the expenditures of large sums of money for certain planned national programs which must dovetail together. When one deals with the expenditures of money and the commitment of nations to such expenditures which, after all, comes back on our side to the Congress and their side to the Soviet Ministry, then their delegations dealt as national delegations.

Mr. FULTON. The question comes up: How shall we fit this into our structure of government? Where does space begin and sovereignty end? We in this country have the sovereignty of the Fed-

eral Government and we likewise have the individual sovereignty of the 48 States.

I am from Pennsylvania. Each State owns above it to infinity. How will we work the national space policy so that we do not get involved, first in a question of Federal sovereignty and, secondly, in 48 State-sovereignty questions? Where do those sovereignties end to you?

Dr. BERKNER. This, of course, is a question that might best be answered by someone who is legally trained. My own view has always been that winged vehicles travel from point to point on the surface of the earth, travel in a space which is certainly controllable by the nations of origin and the nations of destination and, perhaps, the nations of overflight. But when one goes beyond this limit, we certainly already have established the precedent, to which no nation has objected, that satellites for scientific research can fly overhead.

Mr. FULTON. A plane goes 100 miles in the air that would possibly be a security matter to us and something that we would want either to control the method of the type of instrument or the destination, if it was over the United States, would we not?

Dr. BERKNER. This certainly includes, of course, our ability to police any regulations that are established.

Mr. FULTON. That brings into question what our basic view should be. Are we looking at space, as has been mentioned here many times, in the light of the freedom of the seas, as Grotius spoke about it, or are we looking at space the way England looked at it when John Seldon said in 1665 that England must obtain dominion of the seas to maintain its freedom? They had the power to control the seas, and they used it for a good many years.

Or should we start through the United Nations and try to draw up some law on use of outer space. Or, should we go beyond the United Nations? Should we steer away from the politics of the Security Council and the limitations of the General Assembly, where all nations do not assemble, and do as they did in 1899? You will recall that in 1899 the United States joined in the first Hague Conference, and that included every interested nation.

The question then would be: Should we again take the lead, as we did in 1899, or should we let Russia take the lead, as she did in the second Hague Conference when, in 1907, the United States accepted Russia's invitation to a conference at The Hague to talk about the World Court and international questions?

You see, we have once taken the lead and Russia has taken the lead once, on an international conference on a broader basis than just the United Nations. Now, I have favored the latter one. What do you favor? I think it should be first taken up in NATO in a preparatory meeting and then it should be dealt with by the President on a wide area, similar to the Hague Conference.

Dr. BERKNER. You have gone to the very heart of the basic legal problem that underlies the whole space situation. Certainly, something must be done about this very soon, because we all can see problems coming up very rapidly. Let us be specific about these problems. First of all, the very fact that we are launching a series of satellites, each one with a radio transmitter, in itself, will produce a certain amount of radio interference. This interference may deny the use of

the same channels for other purposes. For example, it is likely that the Vangard rocket, with its solar batteries and its small transmitter, will be heard on the frequency of 108 megacycles by your grandchildren. It is said it will stay up from 100 to 200 years.

Now, if large numbers of satellites are launched in a totally unregulated fashion, both by the United States and by Russia and, perhaps, by other nations without thinking ahead of the problems that will be created just because of this interference, we could deny ourselves a substantial communication potentiality.

Mr. FULTON. The same goes for States. Suppose the Commonwealth of Pennsylvania said it was going to put a satellite into orbit, and then each one of the 48 States felt it had to go along, and each college says, "We cannot let the other college get ahead of us, so we will put our own up." Then you get the other fellows down on Y Street who have a rocket club and they decide to put a satellite into space. Wouldn't we have a congestion, a traffic problem and, actually, an outer-space garbage dump?

Dr. BERKNER. I would doubt very much if the States would launch independently because of the interstate interests that should be properly controlled by the Federal Government.

Mr. FULTON. Should we make it exclusive, so that you would require a permit, license, or passport either to go into outer space or to project anything beyond what we would call the ordinary aeronautics channels?

Dr. BERKNER. This is absolutely imperative, but it should be done through international agreement, using some mechanism very much like the one we use in the allocation of radio frequencies.

Mr. FULTON. So, you would not let private citizens do something in outer space without Federal Government approval?

Dr. BERKNER. Or even a nation, without the approval of an agreed-upon international body.

Mr. FULTON. When you come to the international approach, when we set up a space agency, we would have to have a foreign section of the Space Agency just the way the Soviets have a foreign section of their Academy of Sciences, would we not?

Dr. BERKNER. Perhaps, working with a section in the Department of State similar to that which we now maintain to carry on our international negotiations in the field of communications.

Mr. FULTON. The trouble with the Department of State on its sciences attachés is that they are under the Department of State, while the Department of Agriculture has been wise enough to make its agriculture attachés directly responsible to the Department of Agriculture. Would you have these science attachés moved over and be made responsible to a new space agency?

Dr. BERKNER. No, sir; the Department of State must be in a position of negotiating treaties and agreements. I believe this is something that should not be delegated to other agencies of the United States Government.

Mr. FULTON. But the International Geophysical Year was set up, operated, carried out, and is being carried further with no international agreement at all by the United States Government?

Dr. BERKNER. By all governments concerned through a nongovernmental agency; yes.

Mr. FULTON. But it has only been by nongovernmental agencies and not by a treaty, nor by an executive agreement. Is that not correct?

Dr. BERKNER. That is correct.

Mr. FULTON. Then it has been done already.

Dr. BERKNER. Yes; but when it comes to launching large numbers of satellites we are asking for real difficulty if we do not have an international agreement on the control of launchings. Let us look at a specific example. It seems quite clear in the very near future that we shall launch a small number of satellites, perhaps 3 or 4, to an appropriate altitude. These will be either of size sufficient for reflection of radio waves, or with power enough to permit the relay of radio waves, to provide for the equivalent of the whole ionosphere for a new worldwide communications system.

Now, the value of those satellites aloft for communication purposes will be somewhere between $1 billion and $10 billion. This is an objective worth looking at.

The point is that Russia can do the same. Any other nation can do the same and there are strong financial motivations for them to do so. Quite clearly these could interfere with one another, each one negating what the other is doing.

Consequently, it will be desirable for intricate negotiations to be carried out whereby these can be erected and used internationally. Then, far from interfering with one another, they provide each nation with certain measures of communications capability.

Mr. FULTON. You are really rebutting what you have said at the bottom of page 3, last paragraph, about freedom of enterprise in outer space. You say this—I agree with you now but I disagree on the statement that—

I interpret this language as meaning that any qualified scientist can plan and prepare a useful space experiment at his university—

Who would decide what is useful? "At his university" or in his laboratory with the expectation of getting it into space with the cooperation of the Space Agency within the restrictions of the funds and technology available.

This means that the best of American science, wherever it is found, can have access to space through the means and cooperation that its Government provides. This provision insures the healthy growth of space science and avoids a governmental monopoly on one of the important scientific activities of the future.

You see, if it is going to be completely free for the boys in Pittsburgh to put their satellites up as long as they have the cooperation and the use of certain facilities, that is one thing. But if we are going to put in this bill that it shall be a Federal jurisdiction exclusively and deny them access to space, it will have to be on an agency that has a licensing power so that we will, in the Federal Government, issue either licenses or passports for operations or for moving into outer space.

Dr. BERKNER. In my statement, Mr. Fulton, I had assumed that no one except the Space Agency and the Department of Defense would have the privilege of erecting a payload. I had interpreted the legislation as restricting the erection of payload into space by other than the military and the Space Agency.

When I made this statement in my testimony I interpreted the legislation to mean that the payloads would be provided by the Space Agency on which these experiments could be mounted.

Mr. FULTON. Could you make a further statement in the record? We are going to have to go at 12 o'clock. Would you put a statement in the record on that?

Dr. BERKNER. Yes, sir.

Mr. FULTON. I want you to amplify on page 4 that the Space Agency shall have full authority to initiate its own space research directly. That means that we will have the next Columbus go out under the guidance, direction, and authority of the National Space Agency and that is a required authority to be effective.

Secondly, I would like you to have an amplification of the necessity of a new agency to supplement the agencies already there so that we will not be uselessly spending taxpayers' money.

Next, I would like the viewpoint of each of you on the programs that are practical at the present time and that should be pushed promptly. Likewise, the basic research programs that we should be engaged in with study continued for the next 3 to 5 years.

Would you also, please, put in the record the books and pamphlets that you feel are necessary for this committee to study and, secondly, what you would recommend for the layman reader in the astronautic and space field so that we have a good bibliography?

Dr. BERKNER. Yes.

Launching of satellites and space exploration will be a difficult and expensive procedure for as long in the future as we can foresee. In return, such activities will be very remunerative and productive in their results to American science and industry.

Space activities will fall into three general categories:

(a) Scientific research and space exploration;
(b) Commercial activities such as communications systems;
(c) Military activities such as reconnaissance and intelligence.

It seems evident at this time that some forms of international regulation and control of space launching should be adopted to avoid a number of serious problems that are certain to arise. Such problems include:

1. Optimum use of satellites for research to reduce the numbers of satellites in flight to the number necessary. This should be done to avoid unnecessary radio interference between them, and between satellites and the ground;

2. Maintenance of international orbital scheduling to avoid alerts of early warning systems;

3. Effective utilization of satellites for world communications systems;

4. Avoidance of improper use of satellites that may produce deliberate radio interference or other undesirable consequences that might lead to punitive action;

5. Encouragement of international cooperative activity and space research and exploration.

Such regulation and control should be in addition to present activities of the International Council of Scientific Unions in planning specific international space activities and experimental programs.

In view of the cost, the regulatory problem, and the potential international problems introduced by space operations, I believe that

all launchings into space by the United States must necessarily be carried out directly under governmental control and sponsorship. Under this bill, such launchings could be made either under the Department of Defense or the NASA. But I do not visualize anyone else with the money or authority to launch payloads for space science, to direct space stations, or to carry on space explorations.

However, to enjoy the full cooperation of American science, the NASA should cooperate closely with the National Academy of Sciences and individual scientific groups in determining which experiments should be done and in what order of priority. Moreover, qualified scientists should be given the opportunity to carry out their experiments in payloads offered by the NASA so that American science generally has access to space. My original statement was directed to this point.

The NASA is essential to full exploitation of the potentialities of space science. The military applications are necessarily specialized and limited, and the military agencies do not have as their first objectives, the full development of space activities. Moreover, the military agencies should not be overloaded with activities not directly related to national defense. They already have more than enough responsibility to do their job well and efficiently.

In my opinion, the present bill assigns the whole nonmilitary responsibility to the NASA under conditions that will lead to the most efficient, economical, and productive exploitation of space science and the industry emergent from it.

To assess the most useful and effective programs, the NASA might best ask the appraisal of the present situation by the National Academy of Sciences. The NAS by law has the broad responsibility to recommend to the Government at its request, those scientific and technical measures deemed in the best interests of the country. It has access to all American science and engineering. From an appraisal by the NAS, a sound and effective space program should emerge. Such an appraisal should be made immediately and followed by continuing reviews and reappraisals. Guidance of this kind can be of the greatest aid to the NASA.

Mr. Durant. In my opinion the next space flight research project of real significance is not more or larger or more highly instrumented satellite vehicles. Nor is it the lunar impacting and telemetering rocket, nor the circumlunar rocket, nor even the planetary "probes." All of these projects are mere extrapolations of today's satellite achievements.

The next really significant step in the development of astronautics is the manned satellite. This first step of man, himself, into space in a satellite vehicle followed by his safe return to earth will be an achievement of many orders of magnitude greater than any instrumented space flight vehicles even if they carry television cameras.

There is much talk of what man will eventually do in space, on the moon, and so on. However, all manned space flight is contingent upon the achievement of two important developments not yet undertaken, namely:

1. The determination of man's physical capabilities in space, under conditions of prolonged weightlessness.

2. The proof of the technical feasibility of a satellite recovery system which will return man to earth safely to a specified area on its surface.

No plans for manned space flight can go forward without these achievements. This is why I say that a manned satellite flight looms clearly as the next truly significant space flight project. As to a bibliography on astronautics, it seems to me that the one listed on pages 168–174 of the March 1958 issue of magazine Air Force, published by the Air Force Association, is splendid. The February 1958 issue of Sky and Telescope contains an excellent survey of national and foreign periodical literature of astronautics by Frederick I. Ordway III.

There is now a wealth of space literature—perhaps too great—for the newcomer. There are specialized bibliographies, too, for those with particular interests; such as, space medicine, astronomy, propulsion (liquid and solid propellent), philosophy, law, amateur experimentation.

Mr. McDonough. Mr. Durant, I appreciate your contribution this morning. You have given us a great deal of information. As I remember, your statement concerning the possibility of an independent agency for developing basic science for practical application to space technology would be under the jurisdiction of the Space Agency that we are establishing here, as I understand it.

Mr. Durant. Yes; I did not propose another agency of any sort. What I meant in my statement was to delineate certain programs that I believe should be incorporated into our national program.

Mr. McDonough. In other words, I understand you to say that anyone, private citizen, university, or individual equipped with such knowledge that develops any basic information that will be valuable, before it can be implemented and actually shot into space or put into practice, it should be referred and cleared through this Space Committee?

Mr. Durant. Yes, as appropriate.

Mr. McDonough. And the kids in the backyard up in Pittsburgh are not going to shoot rockets into space without the approval of this Agency?

Mr. Durant. Well, I am quite certain there will be no satellites launched by any young people's rocket club although I have, and my record shows I have, given a great deal of time to the encouragement of youth in the study of the subject.

Mr. McDonough. Yes; which I agree with and I think we should have encouragement at the high-school level in the science class to understand the geometry and physical sciences necessary to promote space technology.

Now, in reference to your review of the organization in Russia, you have provided us with a lot of valuable information about the names of those who are members of the interdepartmental commission on interplanetary travel of the Aeronautics Council of the Academy of Science of the U. S. S. R. Do we not have, or do you know whether we have, the counterpart of such scientists in the United States, if we need to coordinate and marshall our scientific resources under such an agency?

Mr. Durant. I am convinced we have not only counterparts but in some cases better scientists. On the whole, I'd say we have the equivalent scientists.

Mr. McDONOUGH. I am glad to hear that. Now with all the implementation of basic scientific law that Russia has been doing since the establishment of their organization since 1955, up to the present time they have shot two satellites into space. They have shot a ballistic missile the full range, so-called; at least we hear they have.

We have shot three satellites into space. We have had a few failures. We have made several advances. We have shot a ballistic missile the full range. For the length of time that we have been at it, as compared to the length of time Russia has been at it, how much further ahead of us are they?

Mr. DURANT. The United States has been engaged in the development of long-range ballistic missiles a shorter time than the Russians. Large size rocket vehicles are the sine qua non of any satellite launching program. The Russians completed the development of reliable big thrust engines earlier than we did because they started earlier.

The Russians put satellites into space because they started earlier and they are ahead of us now because they set up a program earlier, not because of any great technical superiority.

Mr. McDONOUGH. That does not mean that we cannot catch up.

Mr. DURANT. It does not mean that we cannot catch up. I think it is vital that in our planning to catch up that we do not simply duplicate what they are doing.

Mr. McDONOUGH. In other words, even if their scientific organizations do provide, and they of course are studying these matters under the same basic physical laws that we are, there is not any change. They cannot repeal the law of gravity, the cannot magnify it, they cannot change the distances between the planets nor can they change the distances in outer space. So we are following along the same road with any new application of space technology.

Are they better equipped, in your opinion, or do you know whether their industrial capabilities are any better than ours if we had the same information and were attempting to make the same kind of hardware.

Mr. DURANT. I would say our industrial capabilities are greater at this time. These capabilities have not been directed toward space flight. With the type of government that exists in the U. S. S. R. it is possible to bring tremendous effort to bear on specified projects.

I believe the Russian achievements of the fission bomb, nuclear fusion bomb, the MIG–15, and satellites are clear evidence that they can perform important technological feats. To match and exceed such ability, as I have suggested, positive action, creative thinking, a well organized program and powerful leadership are necessary.

We can certainly catch up and we can pass them, but we must organize and plan for it and utilize the best talent willing and interested in such work.

Mr. McDONOUGH. Thank you very much.

Mr. BROOKS (presiding). Mr. Keating.

Mr. KEATING. No questions.

Mr. BROOKS. Mr. Feldman.

Mr. FELDMAN. Dr. Berkner, in response to a previous question you mentioned the fact that it might be desirable to have a joint congressional committee similar to the Joint Committee on Atomic Energy, is that not so?

Dr. BERKNER. Yes, sir.

Mr. FELDMAN. Would that not more nearly function like a board of directors or trustees because they would, in effect, oversee the activities of a commission, an administrator, or director, as the case may be?

Dr. BERKNER. It has been my observation that the Joint Atomic Energy Committee on the whole has looked carefully at all the functions that Congress should properly perform and has had the opportunity under the circumstances to inform itself very fully and very effectively so that the AEC has had the strong support of the Congress.

Mr. FELDMAN. And has assisted it not only on congressional matters but on matters of the budget?

Dr. BERKNER. Certainly. Above all, there have been produced by the Joint Atomic Energy Committee a number of volumes of information which are extremely valuable to the country as a whole.

Mr. FELDMAN. This next question is not particularly pointed to you, because you are not legally trained, but the Administration's bill, in its declaration of policy, has several substantive provisions.

For example, on page 2, beginning with line 7, where it provides for exception insofar as activities may be peculiar to or primarily associated with weapons and so on, that is a substantive provision, of course, that does not belong in a declaration of policy.

I am not going to ask you to agree or disagree with that because that does involve legislative drafting and it is a legal problem primarily.

Dr. BERKNER. I would only comment, Mr. Feldman, that I think without regard to the provisions of this item that whatever would inevitably emerge from the Space Agency, because of its research and ideas, might also have great military value.

Mr. FELDMAN. What would the payoff be in dollars and cents from such a program? I have in mind, for example, the question of payoff in weather predictions, communications, and so on. Would you care to make a statement in that connection?

Dr. BERKNER. In my opinion almost anything you spend on space research will without doubt be repaid within a period of 10 or 20 years. Thereafter, of course, the research will be producing revenue to the Treasury, and income to our citizens.

Mr. FELDMAN. We have had testimony from the head of the Weather Bureau. He said that the cost to the Nation, because of the lack of precise weather prediction, is in the neighborhood of several billion dollars per year, and that could be avoided if we were able to have the proper weather instrumentation through satellites in order to get adequate weather preduction.

Dr. BERKNER. There is very great hope, as I said in my statement, that instrumentation in satellites will give us a new order of magnitude of understanding of meteorology.

Mr. DURANT. I concur very strongly, not only with the possibility of weather prediction but also of worldwide communications. But in a larger sense our minds are simply deficient, our imaginations are too deficient to try to guess the payoffs of things that we have not yet discovered.

Twenty years ago $E=mc^2$ was of no practical value. But this mathematical relationship was the basis, of course, on which we were able to prove nuclear fission.

Mr. BROOKS. I did not get that statement. Would you mind repeating it?

Mr. DURANT. Our imaginations are deficient, sir, with respect to what we can expect to achieve economically from things that are not yet discovered. I point out that Einstein's equation $E=mc^2$ was of little practical value 20 years ago, but appreciation of this relationship, proved in the laboratory, led to atomic energy which has a tremendous economic potential today.

Mr. McDONOUGH. Will the chairman yield for a question?

Mr. Durant, you say that $E=mc^2$ was a formula known 20 years ago and was not implemented until recently? At the time that it was announced, did we do anything about it except work a few arithmetical formulas out of it?

Mr. DURANT. I would rather have Dr. Berkner answer this question. It was essentially a matter that required research to prove and appreciate. The point is that the economic potential of nuclear energy could not be envisioned 20 years ago any more than we can fathom the potential space research today.

Dr. BERKNER. The equation, $E=mc^2$, has been known through most of this century, but it was not until 1938 that Hahn and Strassman doing some experiments at the Max Planck Institute in Berlin discovered the application of this with the fissioning of uranium. Within a few months after that it was announced that an experiment had been repeated in Washington.

Very quickly the thinking developed. You know the history of the organization, of the work under the National Defense Research Committee in 1939 or 1940 which led to the Manhattan project.

Mr. McDONOUGH. Did the original formula have any reference to a possibility of a detonator ballistic missile or object?

Dr. BERKNER. No, one could not visualize at all from that formula what its particular application would be.

Mr. McDONOUGH. But its first application was in the form of a ballistic object?

Dr. BERKNER. Its first practical application was realized in fission of just a few uranium atoms—fission that could be measured and then grew to the application in the atomic bomb and in the nuclear reactor.

Mr. McDONOUGH. Mr. Durant, do we have, as the meteorologists and astronomers have, a charting of our galaxies? Is it charted similar to the chart of the world on meridian and on longitude and latitude?

Mr. DURANT. The astronomers have been charting these things for hundreds of years. I believe astronomical charts are quite excellent for our immediate needs. Naturally, astronomers have searched ever deeper into the heavens since the time of Galileo.

Dr. BERKNER. The charts are reasonably good except half our galaxy is obscured by dust. We are now charting it with radio astronomy which can see through the dust. However, astronomy has been limited to a narrow band of light wavelengths which can penetrate the atmosphere.

This has restricted our understanding of the universe seriously. As soon as telescopes can be mounted in satellites or in space vehicles or on the moon, which is another satellite, it will be possible to see the stars in the full range of the light which they radiate. It is

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anticipated that this step will give a tremendous boost to our understanding of astrophysics and probably lead us to many practical applications on the earth.

Mr. McDONOUGH. But there is an established charting of our galaxy as far as we can see it?

Dr. BERKNER. As far as we can see it there is.

Mr. KEATING. I would like to follow that up. Practical applications on earth of what kind?

Dr. BERKNER. Just as astronomy and other observational sciences on the earth led Einstein to this formula, $E=mc^2$, which in turn led us to atomic energy, certainly as we learn to understand the physics of the stars, we will develop more formulas representing theories that will lead to broader understanding of nature which in turn will lead to more practical application.

Mr. BROOKS. Proceed, Mr. Feldman.

Mr. FELDMAN. I think that Congressman Keating, when he is talking about practical application, has the same feeling I have. We would like to have that translated for us into something real.

Mr. KEATING. That is right. These formulas are not going to do me any good unless I see them with my eyes.

Mr. FELDMAN. I know that we did not anticipate when the Manhattan project was undertaken that we might get a tremendous payoff in the form of isotopes and other things that we do not know about at the moment but which will certainly come.

We know that we have spent over $14 billion on the atomic energy program so far, and that the payoff in isotopes alone has been more than that and will be considerably more in the future.

Now, when you speak of practical application, can you give us some additional information on that?

Dr. BERKNER. In the field of meteorology, which I have already mentioned, through use of earth satellites, we certainly can see the possibility of understanding the physics of meteorology far beyond what we can possibly comprehend from methods previously available. As we learn to understand the physics of the atmosphere, if it turns out that the atmosphere reacts by the multiplication of very small changes, that is, if small instabilities multiply to form the great weather patterns, then we should be able to get large-scale weather control from the physics of that process.

If, on the other hand, it turns out that the great weather patterns do not originate from these small instabilities which trigger the larger effects, then we should get very high probability of prediction—very high prediction effectiveness.

Therefore, one can almost say with certainty that as we understand the physics of the weather, we either will be able to greatly improve prediction or to get some measure of control of the weather situation. One of these alternatives is almost a certainty.

You will get it one way or will get it the other. One cannot say today which way the situation will go—we must await detailed examination of the physics of the situation which modern instrumentation such as instrumented earth satellites now permits.

Mr. KEATING. That is exactly what I was getting at. Of course, if this could result in weather control, it would be the greatest boon that mankind has ever seen within recorded history, I should think.

Dr. BERKNER. Mr. Keating, I think if it turns out that control is impossible to get but that we can get a high rate of prediction, this also would have a value of many billions of dollars a year.

Mr. KEATING. Yes, it would. I was thinking, comparatively, perhaps the control would be greater unless the control, of course, could be used for destructive purposes as well as constructive. It could loose the greatest weapon that man has ever used in warfare, if you got the wrong parties in control of weather.

Dr. BERKNER. The Russians recently published a very interesting paper in which they calculated that if the Arctic Ocean melted at the present time it would not permanently freeze again.

Now, it is not impossible to conceive of melting the Arctic Ocean in one way or another, perhaps through the scattering of lamp black over the ice so that the reflection of sunlight did not occur from the ice and the sunlight were absorbed instead. It is quite evident that if the Arctic Ocean were melted that the heat interchange between the air and the ocean would be completely different than it now is between the air and the ice which now covers the Arctic Ocean. Under these circumstances one could anticipate that there would be a complete change of weather of the Northern Hemisphere. This is an example of how large-scale change of weather patterns might be brought about.

Mr. KEATING. And they say if it melted it would never refreeze?

Dr. BERKNER. It would not refreeze.

Mr. KEATING. How did it freeze in the first place?

Dr. BERKNER. Because the earth was colder in earlier times. We are just now coming out of the ice age.

Mr. FULTON. It would also submerge New York, San Francisco, and London; would it not?

Dr. BERKNER. It would not if the ice in the Arctic Ocean melted, because the ice in the ocean is floating. Only if the ice on land melts would it submerge the cities.

Mr. McDONOUGH. Only the floating ice converted to water would go in the oceans rather than on the lands?

Dr. BERKNER. If the ice on the Antarctic Continent would melt, then it would raise the water level some hundreds of feet.

Mr. FULTON. And it would be a military capability for the person who could do it?

Dr. BERKNER. Of course.

Mr. BROOKS. Is that a Russian theory you are giving us or is that your own?

Dr. BERKNER. This was a paper published by the Russians recently in which they reach the conclusion that if the Arctic Ocean were melted it would not refreeze.

Mr. BROOKS. Does that have any backing by our own scientists? Does it have any support among our own scientists or is that purely Russian?

Dr. BERKNER. This is purely Russian. The matter has not been examined by our own scientists so far as I am aware.

Mr. BROOKS. Mr. Feldman.

Mr. FELDMAN. We realize now that there is a quid pro quo for any expenditure that we may make in this field. Do you believe that the programs that you recommend are related to the military space programs?

Dr. BERKNER. No, sir, quite to the contrary. I think if the military are not burdened with need of carrying out space programs which are of nonmilitary character that they can get along with their own job better. I think, further, that a research establishment of the kind inevitably visualized by this bill would produce many products which would have military utilization and which the military could use.

I see nothing in this bill which would prevent the military from exploiting any discovery in the field of space which had any military implications.

Mr. DURANT May I interject here that I believe that an extremely close relationship between the military and the civilian scientists must evolve in space-flight research. This teamwork, as characterized by the National Defense Research Council (NDRC) and the Manhattan project of World War II must somehow be repeated in a National Space Agency.

Mr. FELDMAN. One of the most bothersome problems in connection with this bill will be the question of security. I notice that you testified before the House Information Submittee headed by Congressman John E. Moss of California on the question of classification.

Have you any observations or any comments you care to make in this connection?

Dr. BERKNER. It is my feeling that we have already established a sensible pattern in the International Geophysical Year. In the IGY we are exchanging full information with respect to payloads. These are the scientific experiments that are being conducted by means of the satellites. We have certain restrictions with respect to the characteristics of our launching rockets both on the side of the Soviet Union and on the side of the United States.

I would anticipate that within 10 years these restrictions would gradually fall away as rocket technology becomes as standardized as aviation has become over the last 2 decades.

Mr. DURANT. I concur in it Dr. Berkner. There is a vast amount of research to be conducted that, at least at the present, has no security implications.

Mr. FELDMAN. Have the Russians undertaken any declassification of this scientific material?

Dr. BERKNER. Yes, sir. I gave you an illustration of a very considerable declassification of their scientific material in the material that I entered into the record earlier this morning. Moreover, they have declassified the details of some of their rockets.

Mr. DURANT. Five excellent scientific papers on astronautics were presented at the VIII IAF Congress last October in Barcelona.

Mr. FELDMAN. Are you acquainted with any of the details concerning military classification and declassification in the United States?

Dr. BERKNER. Yes, I am quite familiar with many.

Mr. FELDMAN. Have you any comments to make in that connection?

Dr. BERKNER. I believe that insofar as possible one will gain by declassification of both Soviet and United States rocket details. It must be quite evident to all of us that it would be useful to know in greater detail how they made their launchings of their very heavy satellites.

Mr. FELDMAN. Would it help the scientific community to have greater declassification or greater exchange of classified material?

Dr. BERKNER. With respect to the launching of vehicles I would refer this question really to Mr. Durant. But with respect to the pay loads, I think we should keep these entirely unclassified in the space work as they are now.

Mr. DURANT. My comment on that would be that with respect to security on the rocket launching vehicles of our Vanguard satellites, it was pointed out in the President's announcement that all the details concerning satellites, instrumentation and the results obtained therefrom would be made freely available to the international scientific community.

It follows logically that the launching vehicles, because of their close relationship to ballistic missiles and other types of rocket weapons, might be in a security classification status.

Scientists generally would expect in satellite research to be concerned only with the altitude, velocity, g-loading weight and cubic content of the satellite (within which to place instrumentation) and the measurements to be performed, not how the satellite was placed in orbit.

Dr. BERKNER. I think Mr. Durant would agree that there are some forms of launching that would have no military value and can be declassified in the future. For example, launchings which would take place from space platforms might be of the ion variety, or something of this sort, in which they would be very different from military rockets and could be completely declassified.

Mr. DURANT. I agree with that.

Mr. FELDMAN. What is your view as to world opinion regarding United States leadership in astronautics?

Mr. DURANT. I would say that the world opinion at the moment is that the United States is not leading. In fact, I think there is rather a vacuum. The United States led from July 29, 1955, until October 4, 1957. At that time the U. S. S. R. clearly established their leadership, which they underlined on November 3. Since that time of course there have been no launchings by the U. S. S. R. of satellites or announcements, but I think we may expect them in the next few months.

But I believe that this leadership which they still enjoy is dwindling unless they take further positive action. This is the sort of positive action that I recommend to the United States.

Dr. BERKNER. If I could add to this, I would hope that before the end of this year in the field of obtaining scientific measurements in space that the United States might achieve leadership.

Mr. FELDMAN. Earlier in your testimony I believe both of you, Dr. Berkner and Mr. Durant, alluded to the fact that we should not try to match the Russians but to program this thing separately. Would you say that we should try to leapfrog them to the extent of trying to develop a missile—well, first, try to catch up with them in the field of large powered thrust engines and then leapfrog them by developing a spaceship or space vehicle?

Dr. BERKNER. Certainly large thrust engines will be useful in the future and should be developed and as reasonably quick as economics will permit. With respect to a space station, I would prefer withholding comment until this could be given more thorough technical study than has been given to date.

I think there are some serious technical questions which have not yet been completely solved. Certainly Wernher von Braun has given

serious consideration to this matter. There have been a number of other proposals, but I would prefer an independent critical examination of this whole matter before committing the United States to what might prove to be too large an expenditure at this moment.

Certainly we should get on with the study and with all of the research necessary to make the study definitive as quickly as possible.

Mr. DURANT. The development of reliable rocket engines, larger than any we have now, will be required in a few years for space flight. Contracts should be let now for this development.

Mr. FELDMAN. Are scientists of the United States contributing adequately to space-flight research?

Dr. BERKNER. My attitude is that you cannot hold them back. They need only the money and the means to get on with the job.

Mr. DURANT. I would like to comment, purely for the record, on the history of how the satellite experiments were originally judged and chosen for the Vanguard program. Those satellite experiments came out of a meeting which was called in January 1956, at Ann Arbor, by invitation of the Upper Atmosphere Rocket Research Panel, in conjunction with the IGY National Committee.

There were some 30 or 35 experiments proposed by a selected number of invited guests. By no means was the scientific community widely solicited.

Take one example, the area of cosmic radiation. There were many excellent cosmic ray physicists who were never invited or given an opportunity to participate. The same is essentially true of the other scientific disciplines in which experiments were to be made.

I would say that to date, in my opinion, it is simply a matter of modus operandi and an invitation to participate and they certainly would jump at the chance. I think it would be wider.

Mr. FELDMAN. Can you tell us something about the history and aims of the International Astronautical Federation?

Mr. DURANT. This is contained, sir, in the brochure which I believe is to be made a matter of record.

Mr. BROOKS. Let me interrupt the proceedings at this point to say that the bells have just rung. May I ask you two questions at this point. I noticed recently in the Southwest a statement made by Frederick G. Saurma, who is assistant to Von Braun. He said the Russians have fired 16 shots at the moon recently and apparently failed.

Do you have anything along that line?

Dr. BERKNER. I have no information.

Mr. DURANT. I have no information at all, Mr. Chairman. You say he is identified as an assistant to Dr. von Braun?

Mr. BROOKS. That is what this dispatch says—

> Rocket scientist Frederick G. Saurma said last night reports coming out of Russia indicated that the Russians had fired 16 shots at the moon and failed. The assistant to Dr. von Braun at Redstone Arsenal, Huntsville, Ala. * * *

Dr. BERKNER. I have no information. I would refer you to our intelligence agencies.

Mr. BROOKS. Mr. Ford.

Mr. FORD. Mr. Durant, I noticed on the last page of this paper, Commission on Astronautics, Academy of Sciences, U. S. S. R., the listing of the members of the Interdepartmental Commission on In-

terplanetary Travel of the Astronautical Council of the Academy of Sciences, U. S. S. R., some 27 individuals.

Generally, are these men in the older age group or are they in the relatively younger age group?

Mr. DURANT. I would merely guess their average age is in the order of about 40; 35 to 40.

Dr. BERKNER. These extend over this age group and up to the age perhaps of 62 or 63.

Mr. DURANT. As well as down to perhaps 28.

Mr. FORD. In other words, a substantial portion of them have come in the more recent years into the hierarchy, so to speak, of the scientific community through their own accomplishments, as indicated by their appointment?

Mr. DURANT. Yes.

Mr. FORD. Dr. Berkner, on page 3 of your statement you mentioned chromaticity. What is that?

Dr. BERKNER. The range of light which can be seen through the atmosphere. We can see only about one octave of light. If we were above the atmosphere we could see all of the wavelengths radiated by a star or any astronomical body.

Mr. FORD. We could see them with instruments, not with the naked eye?

Dr. BERKNER. That is correct. The naked eye only responds to this one octave that passes through the atmosphere.

Mr. FORD. That is all.

Mr. BROOKS. Any further questions?

Mr. FULTON. I have one question.

Mr. BROOKS. Mr. Fulton.

Mr. FULTON. You commented on the value that further research would have on measurements in space. Actually in addition to weather the measurements of the earth would be a very great gain, would it not, so that we would know the circumference of the earth as well as the location of various points on the earth?

Dr. BERKNER. That is correct.

Mr. FULTON. At the present time, there is no adequate mapping of the earth, nor is there anything in the United States, other than a triangulation system from a point in Kansas, to determine our distances, is that not right?

Dr. BERKNER. That is correct.

Mr. FULTON. We, as a practical matter in science, do not know yet whether there is a drifting of continents and we might be able to determine from a point in space whether these continents are drifting?

Dr. BERKNER. It is very probable that the operation of Vanguard 1 will tell us that in a century.

Mr. FULTON. We also might be able to remove one point of friction and that is how far Washington is from Moscow because we do not know that yet. The Russians think it is one distance and we think it is another.

Dr. BERKNER. We think we know this distance to better than a mile.

Mr. FULTON. But we are not sure?

Dr. BERKNER. We are not sure. With the satellites we soon should know it to about 30 feet.

Mr. FULTON. The Russians think it is closer and we think it is farther?

Dr. BERKNER. We should be able to agree on this.

Mr. BROOKS. May I ask this question: In reference to the control of weather you have stated, as I recall, that is a long-range basic situation. If that is the controlling influence, it would give us an opportunity to better predict further weather, whereas if weather is determined by local vagaries, then it would furnish us a possibility of controlling the weather.

Down in the lower Mississippi Valley I have worked with the Weather Bureau very closely and weather information is vital to us. We just had a 10- or 12-inch rain down there.

Could you elaborate a little bit on that?

Dr. BERKNER. Yes. To try to make it clear, we do not know now whether very small disturbances in the weather tend to multiply and become the main disturbances, or in the event that this happens, which of the small disturbances do this.

Now, should this growth be the case, that is if certain kinds of small disturbances can multiply to cause the real big disturbances, then control should be possible by exercising control of these small disurbances or perhaps generating disturbances of the kind you may want to grow. If, on the other hand, this turns out not to be the case, namely that the atmosphere is not unstable in this way, then we should be able to bring our prediction capability to nearly 100 percent, but we would then find our control more difficult.

Mr. BROOKS. Over a very long period of time you might extend your predictions in the future?

Dr. BERKNER. That is correct.

Mr. FULTON. Mr. Chairman, I should like to insert in the record at this point an article by Dr. Berkner entitled "Man's Space Satellites", which was printed in the Bulletin of the Atomic Scientists.

Mr. BROOKS. Without objection that may be inserted in the record.

(The document follows:)

[Reprinted from Bulletin of the Atomic Scientists, vol. XIV, No. 3, March 1958]

MAN'S SPACE SATELLITES

Lloyd V. Berkner[1]

"Saturday, November 16—Key West 2:55, Savannah 2:57, Atlantic City 2:59, Presque Isle 3:01, Van Horn, Texas 4:40, Dodge City 4:42, Minneapolis 4:44, Pierre 13:40, Fort Smith 13:43, New Orleans 13:45; San Francisco 15:25, Los Angeles 15:27, * * * (the New York Times schedule of Soviet Satellite II).

Thus we are daily reminded that on October 4, 1957, man made his first escape from his imprisonment on the surface of planet earth Even more than nuclear energy, the satellite symbolizes the cohesive force of science in bringing together and cementing political, social, and economic elements of man's civilization. For it shows us science, not as a thing apart from man's daily activities but as an all-pervading force that influences every aspect of human existence—not just man's material welfare, nor his political and military posture, but his humor, literature, and poetry as well. In acquiring his newly won, three-dimensional freedom he is reminded that he enjoys greater opportunity than the simple material existence of the anthill—an opportunity for curiosity, exploration, and comprehension—the intellectual power that makes man more than the ant.

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[1] Lloyd V. Berkner is president of Associated Universities, Inc., among whose activities are the Brookhaven National Laboratory and the National Radio Astronomy Observatory. He is president of the International Council of Scientific Unions president of the International Scientific Radio Union, and vice president of the Special Committee for the International Geophysical Year, as well as IGY reporter for rockets and satellites.

What is a satellite for?

But just what is this satellite that has hurtled into our view What does it mean to our immediate future? As a simple scientific tool the instrumented earth satellite is a device of superb potentialities, comparable to such other great scientific instruments as the telescope, microscope, or nuclear accelerator. It provides access to secrets of our environment that can be acquired in no other way. For of all the planets, the planet earth on which man lives is one of the most difficult to observe. This is because of man's limited visibility of the earth's surface and his relative isolation. We are sandwiched between an insulating atmosphere above and an impenetrable earth beneath The protective atmosphere above admits but a single octave of light and a few octaves of radio waves from the heavenly bodies. The result is an almost monochromatic view of the universe.

The artificial satellite now permits us to see the universe for the first time in its full range of "color," in the special sense that the satellite broadens the range of our vision from a narrow spectrum of vision to the whole spectrum of nature—from the shortest to the longest wavelengths, from the lowest to the highest particle energies.

But above all, the manmade satellite provides the first step toward man's dream of interplanetary travel, a dream that is now almost realized. Over and above the adventure itself, and quite apart from the unevaluated advantages of occupying other planets, the scientific knowledge to be acquired in such exploration is prodigious. That there are some forms of life on Mars, for example, seems quite certain. The difference in evolutionary patterns under presumably independent circumstances could easily provide basic keys to the origin of life itself. This is but a single instance of a wide range of extraordinary scientific vistas that will be opened to the interplanetary voyager.

What is it?

The satellite itself consists of a polished metal sphere that houses the elements necessary to its successful scientific performance Among these elements is, first of all, the experimental apparatus. Second, the satellite contains a means of recording the results of the experiments. The experimental data recorded and accumulated during each orbit around the earth are best stored in the form of electrical impulses describing these results. The satellite also contains a radio receiver to advise it when to release its stored information and a radio transmitted to convey the information to the ground upon request. This means of storage, interrogation, and transmission is known as the telemetering system. To conserve electrical power, the telemetering transmitter may be designed to act only when properly interrogated by an appropriate radio station on the ground, and, upon interrogation, to transmit its information to a station on the earth for permanent recording. Third, the satellite must contain a radio beacon so that it can be seen in the radio frequency spectrum by appropriate radio receivers on the ground.

Of course, the satellite can be seen visually under certain circumstances—for example, an hour or two before sunrise or after sunset—while it is still illuminated high overhead by the sun. This luminosity can be increased by trailing a large reflecting balloon filled with a breath of gas, or by retention of the final launching rocket. But the latter produces an orbit that will generally deteriorate more rapidly because of the greater resistance of the attached bodies to the surrounding air. Visual observations may, moreover, be obscured by clouds, and, at any rate, are not frequent enough to provide the information needed about the satellite's exact track across the sky. With its radio beacon, the satellite can be seen at any time of the day by suitable radio stations.

The United States version of the satellite is a little more than 20 inches in diameter and weighs approximately 21½ pounds. But compression is only one difficult element of the design of this satellite It must operate in space where, in the shadow of the earth, its temperature may drop toward absolute zero, but, when exposed to the full glare of the sun's rays, may rise toward the melting point. It is extremely difficult to design apparatus for a satellite which can be kept at a temperature at which its components will remain operable Gold has most suitable radiative properties, so that many of the internal components are plated with gold.

What sort of orbit?

The first satellites of both the United States and the Soviet Union travel in a generally easterly direction to take advantage of the earth's rotational energy At the altitude nearest the earth's surface—the perigee—the satellite can be a little more than 150 to 300 miles overhead. (The maximum height at perigee of Sputnik I was reported to be 156 miles.) But the orbit will be usually rather elliptical, reaching distances at apogee usually rather more than 600 miles and for some orbits reaching perhaps 2,000 miles or more overhead. (Sputnik I reached 586 miles at apogee.) In these orbits the satellite will circle the earth once each 90 to 100 minutes—that is roughly each hour and a half—so that it will complete about 14 or 15 round trips each day.

Since information must be repeated back to interrogating stations during each round trip, the earth will receive the scientific information from each satellite about 15 times a day. The earth rotates 15 degrees each hour under the satellite, so its surface advances something more than 20 degrees or about 1,000 miles as the satellite completes a round trip. Consequently, the whole surface of the earth is scanned each day, for a satellite at 300 miles can scan a band more than 1,000 miles wide. In later satellites, as altitude is increased, the period of rotation around the earth will be lengthened. Of course, our only natural satellite, the moon, which is 240,000 miles above the earth, circles it about once each 28 days. It is conceivable that a satellite could be launched at just the right location, altitude, and velocity to cause it to hover almost stationary overhead. Such a satellite would be a few earth's radii overhead. Other possibilities included a north-south orbit passing over the poles so that a satellite would need only 1 interrogating station at 1 of the poles: though without internally imposed correcting forces it would slowly precess from such an orbit. Alternatively, a satellite might be made to follow an orbit along the sunrise-sunset path so that it would be easily visible at all times and could view the sun continuously.

The range of the orbit north and south of the Equator cannot be less than the latitude of the launching site, though it can be more. Thus, the selection of the launching site puts some restrictions on possible orbits. The United States, in launching its satellites from Cape Canaveral, Fla., provides an orbit that scans the earth from about 40° north and 40° south. On the other hand, the Soviet Union is launching its satellites at about 55° north on an orbit that scans the earth approximately between the Arctic and Antarctic circles. But the satellites of either nation could eventually be made to scan the whole of the earth by selection of suitable launching azimuths, though of course some additional launching energy would be required for a north-south or more westerly launching to compensate for the loss of the earth's rotational energy.

What do satellites mean to meteorology?

We learned in high school that the earth's atmosphere can be regarded as the gas of a kind of heat engine that receives a net gain of energy from the sun, mainly from midlatitudes to the Equator. The equatorial region is the firebox and stores much of the energy in water vapor that is evaporated. The atmospheric gas suffers a net loss of energy by radiation poleward from midlatitudes. Thus, the polar regions are the condensers of this great heat engine. The earth's atmosphere is perhaps the only great heat engine that uses a radiator as a condenser.

The transfer of heat from firebox to condenser involves the circulation of the energy carrying gas in the connecting space—the circulation of the atmosphere that brings us our weather. The circulation of a gas over a rotating sphere in this way involves coupling of several successive circulation cells and tends not to be very stable. Unfortunately, the heat input and the output to the engine are not constant. The input changes as variation of equatorial cloud-cover reflects more or less of incident heat from the sun back into space; the output depends on the reabsorption of radiated heat in the atmosphere, as the space-distribution of gases within the atmosphere that reabsorb the heat radiated from the surface is modified. Furthermore, a small change in rate of overturn of the oceans can change the heat supply to or from the atmosphere locally.

Finally, the energy collected by the trade winds and fed into the troposphere through the huge equatorial thunderstorm cells near the meteorological equator—of which perhaps 5,000 normally occur each day—may fail to form locally or may direct energy into the wrong hemisphere to produce temporarily hemispheric unbalance of stored heat All of these localized changes in input and output tend to upset the already doubtful stability of the atmospheric flow.

The circulation of heat from the equatorial regions toward the poles is not as simple as it would be through a series of pipes. Instead, the heat is conveyed through couplings between a series of vertical circulation cells successively in the equatorial regions, in the temperate zones, and in the polar regions in each hemisphere. Sometimes these cells do not transfer heat from one to another as expected, with a resultant delay in the heat transfer and consequent buildup of unusually hot and cold spots, or a rerouting of the ordinary flow patterns. The delay may extend for a considerable time, but when the breakdown does occur, the effects on the weather may be radical or even catastrophic. Such gross effects cannot be traced or understood until the whole earth is observed at very frequent intervals with appropriate measuring devices

The satellite holds promise of revolutionizing our powers of observation in the field of meteorology. Among the early satellite experiments will be the attempt to measure the heat balance of the earth and the variation of the heat balance from place to place by a method designed by Professor Soumi, of Wisconsin This will implicitly involve measurement of the albedo of the earth and the input and output radiation. Not far behind will come experimental mapping of the cloud and storm systems over the whole earth by the method developed by Dr. Stroud, of Fort Monmouth Signal Laboratories This involves delineation of changes and movements of storm systems at frequent intervals, and the observation of cyclogenesis. The location of the hot and cold spots in the sense of excessive input to or output from the atmospheric heat engine is certainly feasible with the earth satellite. It should not be difficult to count thunderstorms or even flash-frequency of lightning on the dark side of the earth or "radio-static" discharges produced by lightning on either the sunlit or dark hemisphere, and to map development and movement of active frontal areas. Moreover, the capability of the satellite to scan the earth quickly, and to store and transmit a large quantity of data on request, will suggest many other powerful experiments critical to meteorology. To what extent do meteoric dust particles of microscopic size vary in density from place to place as they are swept up by the earth as it courses along its orbit? Are such particles of meteoric dust of the kind and numbers that can influence rainfall, as Prof E. G. Bowen has suggested?

What about solar radiation?

We usually think of the sun as a fixed star. In fact, the visible radiation from the sun is defined in the terms of a solar constant based upon radiation transmitted through the atmosphere. But radiation of short wavelengths, the ultraviolet and X-radiations from the sun, are absorbed in the high atmosphere and cannot be seen even from the highest mountaintop. Fleeting rocket observations have shown very large variations in solar radiations at such short wavelengths, variations that are more than 100 to 1 even when the sun appears quiet. With only minor visible manifestations such as small eruptions in the sun's chromosphere, the IGY rockets have found an immense increase in ultraviolet and particularly X-radiation, so that X-ray wavelengths as short as 1 Angstrom penetrate deep into the atmosphere and can be seen only 35 miles overhead. Clearly, it is important to understand the character and variation of these otherwise invisible radiations from the sun. This the satellite can do superbly with spectroscopes or simple telescopes with banded filters. By continually recording the radiation of the sun from a vantage point outside the absorbing atmosphere, the satellite can provide us with a complete story of the character and intensity and variation of solar radiation in the whole radiative spectrum. Where this knowledge will lead no one can say

What can we learn about the exosphere?

The exosphere is the region of the atmosphere extending outside the level of the outer or F-region of the inonosphere more than 250 miles overhead Ordinarily, radio observation of the exosphere is not possible because of the shielding of the intervening ionosphere. Yet there is increasing evidence from many sources that the exosphere plays an important and interesting role in our general environment. It is a region traversed by primary cosmic rays where they are deflected by the geomagnetic field. It is the region of first impact on our atmosphere of streams of solar corpuscles ejected by the sun that produce geomagnetic disturbances and auroral displays when intercepted and deflected by the magnetic field of earth. It seems very likely that the sun's corona extends through the earth's orbit, so the exosphere is actually the region of coupling between the corona and the earth's atmosphere.

Quite aside from these classical examples of the influence of the exosphere upon our environment, recent studies of that strange phenomenon known as "whistlers" have greatly stimulated our interest in that region. Whistlers are electromagnetic waves of a very low frequency—a few thousand cycles—that were first heard on telephone lines in the Alps in 1886. Whistlers arise from lightning flashes whose resultant field appears to travel through the exosphere far into space. In the presence of tenuous ionization of the exosphere, they are propagated along lines of force of the earth's magnetic field, following the field down to the opposite hemisphere where they are reflected back over the same path to the point of origin. Thus, they are heard sometimes with many successive multiples, spaced by a second or two of time, as they bounce back and forth between one hemisphere and the other. As many as 15 or 20 successive multiple reflections have been observed. Strangely enough, a late multiple, perhaps the 5th or 10th, is often stronger than the original whistler, as though the wave were amplified as it traveled. Particle streams from the sun, acting as a cathode and intercepted by the earth, are focussed in the earth's magnetic field to form a kind of traveling wave tube amplifier. It happens that whistler waves traveling in the exosphere are propagated at the proper velocity to acquire energy from the incoming particle streams, and seem thus to be actually amplified as the solar streams of particles enter the exosphere. Moreover, the impact of fronts and irregularities of the particle streams themselves on the exosphere appear to generate low frequency radio noises that are identified as "hooks" and "hisses."

The whistler is only one example of the influence on our environment of the exosphere where the atmosphere and magnetic field of our rotating earth is coupled to the contents—the fields and particles and debris—of surrounding space. The satellite provides us with means of studying this external region. By means of proton magnetometers or similar devices, it is possible to measure the strength and direction of the earth's magnetic field at great heights. It should be possible to ascertain directly whether this field is distorted at great distances above the surface as it is coupled to the particles traveling through the space of the earth's orbit. It will be possible to ascertain whether the deflection of incoming streams of particles, under the influence of the geomagnetic field, form ring currents that may encircle the earth, and to measure the intensity of such ring currents when they appear. The role of incoming particle streams in forming the aurora can be studied at first hand and the changing spectra of the aurora extending into the X-ray spectrum can be observed as aurorae develop. It should be possible to carry out experiments in the very regions where the traveling wave amplifier is operative

The satellite can make direct measurement of the energy and intensity of incoming particles and particle streams including both soft and hard primary cosmic rays The cosmic ray experiments contemplated for the satellite experiment involve continuous recording of cosmic ray counts. For this purpose a magnetic tape recorder, weighing only about 6 ounces, has been devised to register this information and to repeat it back to the interrogating telemetering station

What else can satellites tell us?

At this point we should consider some of what might be called the "free" experiments that can be done by the satellite These are experiments that require no special instrumentation, but only observation of the satellite orbit and its perturbations The first of these is the measurement of atmospheric density at the great heights at which the satellite will travel. Density can be derived directly by measuring the rate of acceleration of the satellites along their orbits. As a satellite loses energy to the surrounding tenuous atmosphere, its height diminishes, but of course its orbital rate increases in the smaller orbit. As it slowly descends into more dense atmosphere, it will distort and heat behind an ever enlarging air-cap until its burns out brightly in a slowly descending path. Atmospheric parameters are of the utmost importance to the life of the satellite, since the higher the density the shorter the life The uncertainty of atmospheric parameters at the levels of proposed orbits makes it difficult to predict what the life of a particular orbit will actually be until more experiments have been completed and evaluated But it now seems safe to predict that with the perigee of the initial orbit above 300 miles, the lifetime will be several years.

A second free experiment involving observation of the successive positions of a satellite relates to geodesy. Here, two distinct aspects of the orbital motion must be considered—the dynamical and the geometric. The dynamical observations involve observation of the perturbations of the satellite orbit on successive

rotations to deduce something concerning gravity anomalies. In connection with other information, these observations can tell us a great deal about the distribution of matter within the earth. By the geometrical method, that is the accurate observation of the satellite in a number of positions along the same or successive orbits, we can derive direct information concerning the shape of the geoid, and the precise location of the points over the surface of the earth with respect to one another. The accuracy foreseeable by these methods should permit us to establish within a reasonable space of time, perhaps less than a century, whether movements of the earth's crust or continental drifts actually occur. In this way, direct evidence relating to convection in the earth's interior can be derived.

Another "free" experiment relates to the determination of total ionization in the exosphere between the ionosphere and the level of the satellite. At low altitudes in the sky, while the satellite is rising, the waves from its radio beacon must pass through the ionization of intervening space in such a way that they will be refracted toward the zenith. Therefore, near the horizon the satellite will appear to the radio receiver to be higher in the sky than it appears by direct visual sighting. Near the zenith, this difference disappears. When the angle between the radio and visual position is measured at a known altitude, the total ionization between the earth and the satellite can be readily computed, since refraction of the radio waves by ionization has caused the radio sighting to be elevated. If one subtracts the ionization between the earth and the level of maximum ion density of the ionosphere—which is known from other radio measurements—we shall have remaining the total ionization between the ionosphere and the satellite itself. At a given station on successive orbits the satellite will appear at different heights ranging successively from 300 to perhaps 2,000 kilometers with the precession of the nodes, so that such a succession of measurements should provide the numerical distribution of ionization through the exosphere.

Some of these measurements have not been possible on the early Soviet satellites because of the low radio beacon frequencies of 20 and 40 megacycles. The strong and unpredictable refraction of these low wave frequencies in the ionosphere do not permit sufficiently precise measurements of location to establish the orbit with the needed precision. But on the other hand, since the 20 and 40 megacycle wave frequencies are near the initial penetration-frequency of the ionosphere, and since the sputniks plunged through the F-region of the ionosphere when they approached perigee, interesting new properties of the ionosphere have been deduced.

Among other possible experiments is the measurement of the gravitational redshift. This general kind of experiment is mentioned in the paper on the Russian satellite transmitted to me by Academician Bardin. In the study of many basic aspects of science it is of vital importance to determine whether the gravitational redshift is observed as supposed from theory. The whole question of the properties of time as it enters dimensionally into our theories depends on the outcome of such a test. One way of undertaking this test, being considered in the United States, would be to compare the relative time kept by two atomic clocks—one in the gravitational field on the surface of the earth and the second one high above the surface where the gravitational field is significantly weaker. Using the atom of cesium, Professor Zacharias of MIT recently has developed an atomic clock which is potentially capable of keeping time to at least one part in 10^{12} (a billion billion). Although this precision has not yet been fully achieved (present clocks keep time to a part in 10^{11}, a hundred billion), the realization of a light-weight atomic clock of the required quality seems feasible within the next few years With such precision of time made possible by the atom, the erection of one such clock in the earth satellite would permit the direct conduct of the redshift experiment by measurement during a single, or at least a few complete orbits.

A second experiment involves the mounting of optical telescopes on the satellite itself. This was suggested to me some years ago by Professors Spitzer and Schwarzschild at Princeton. The satellite is actually a highly stable base that can be rotated through tiny angles on the quite frictionless bearings of the surrounding vacuum and controlled with the greatest precision by a mere breath. Not only is such control not difficult when referenced to positions of fixed stars, or points on the earth, but it is generally easier than the control of conventional telescopes on their awkward mounts. Such telescopes can work over enormous frequency ranges, or spectra, of "light," compared to our vision from the surface of the earth where the width of spectra now observed through the

atmosphere is very restricted. This possibility of looking at distant stars, and galaxies, and galactic groups in their full range of color opens a whole new vista to the astrophysicist in his study of the processes of the creation and ultimate destruction of matter. Within relatively few years, telescopes of a size equivalent to the largest telescopes on the earth can be arranged on instrumented earth satellites so that the full information that the universe provides will become available to man.

What about space technology?

In view of the satellite's great significance the question of the organization and administration of space technology becomes a matter of crucial importance. Specific plans for scientific satellites are now projected only during the Geophysical Year. Looking to the future, the United States must make a number of clear decisions of policy. First, will it press forward in space technology as a matter of policy? If it does, will it do so in isolation by within national limits, or will it join its space efforts genuinely with other nations through joint laboratory and launching efforts? Since not many nations can sponsor an independent space effort, a policy of isolation would exclude the opportunity for capable and energetic scientists of smaller nations from their aspirations to contribute to space technology. If international effort is undertaken, should the United States sponsor such effort under the auspices of a group of friendly nations, or as a complete world effort in which all nations are involved?

Whatever international courses are chosen, the character of our internal organization is of vital concern. One might argue that space technology should be developed under the wing of the military services Undoubtedly, the satellite has military implications of its own, quite apart from the military capabilities implied in the ability to launch it. Moreover, the great rockets required to launch heavy satellites are available from the military stockpile, and at the moment the greatest skills in rocketry are under the supervision of our Department of Defense. Consequently, it might be thought that greater economies of effort could be achieved in this way. Certainly strong arguments can be advanced for military control of future satellite development. But these arguments have a certain superficiality that misses the significance of the satellite as a social development The extension of geography into space should be a peaceful project, as President Eisenhower has advocated Just as the initial planning for satellites for man's benefit was conducted in the friendly atmosphere of international scientific circles, so the future international discussions of space programs should be free of the rigid domination of the uniforms of the world

This is not to say that the military organizations should not play their part in the conquest of space. Certainly, they have many skills and facilities that are needed, and they have a legitimate interest in the subject. But space conquest should be primarily for intellectual and social rather than military ends. We must recognize our conquest of space as a superb manifestation of man's control of his environment that far transcends its incidental military relevance to the interrelationships of men and nations.

Who should control United States space plans?

Our Nation faced a similar decision in planning the future of nuclear energy. Nuclear development has a relation to military strength at least equal to that of space technology Yet our decision, and I believe it was right, was to place its direction under a civilian agency, the Atomic Energy Commission. For nuclear energy had civil and peaceful as well as military implications. Whatever the defects of that organization, no one would suggest that it has in any way hampered the growth of United States military strength On the contrary, our nuclear military strength is in the unquestioned vanguard of our national scientific achievement At the same time, a civilian AEC provides the mechanism through which "atoms-for-peace," and other friendly international activities sparked by the atom can aid in breaking down international tensions.

Similarly, the full scientific and social potentialities of space technology, in my opinion, can best be realized under a civilian Federal agency. The direct consequences of carefully designed space researches will react on every aspect of man's existence and will radically influence his adjustment to his environment. The purely scientific problems involved are complex and their solution can be best achieved under civil auspices closely related to the academic atmosphere, because they transcend the normal limits of military technology. Even the advanced rocket techniques that are needed must presently far outstrip the military

needs, and in fact, will often differ radically from military designs. Certainly great laboratories will be required, and these should enjoy the intimate relationship to university activities that grows out of broad civil direction of national programs.

In the present state of unstable military equilibrium, it is natural that we should be concerned for our military strength and effectiveness. With the gravest consequences at stake, no nation can afford to tip the balance adversely by weakening its military strength. But in facing the future of space technology with a biased emphasis on its military aspects, there is danger that we may fail to grasp the real opportunity for world leadership that space technology offers. Militarization of broad problems such as space technology that affect all elements of our national community suggest a considerable danger of our Nation succumbing too completely to a psychology of military direction and control Instead, a more balanced approach is needed through which all elements of our society—including the military—have an equal opportunity to contribute. We must not forget that it was the Soviet Academy of Sciences and not the Red Army that negotiated the plans for the launching of the first earth satellites.

The challenge of the earth satellite will not be simple to meet, nor can it be met by passing off responsibility on some special group, or by seeing the challenge solely in military terms. It is an instrument that enables man to view his problems in new perspective and provides him with incalculable advantage. Space technology represents a broad intellectual challenge that must be met with an equally broad response from all elements of our national community. We must plan so that wisdom rather than expediency dictates our course.

NOTE.—This article includes material drawn from a special convocation given at the University of Maryland, December 11, 1957, and from the IGY Manual on Rockets and Satellites, Annals of the IGY, Pergamon Press, 1958, edited by L V Berkner, et al.

Mr. BROOKS. If there are no further questions, the committee will adjourn until 2:30 o'clock this afternoon. I want to thank you gentlemen for coming before this committee and giving us the benefit of very fine testimony.

Dr. BERKNER. Thank you.

Mr. FULTON. I join in those thanks.

(Whereupon, at 12:20 p. m., the committee recessed to reconvene at 2:30 p. m., the same day.)

AFTERNOON SESSION

Mr. McDONOUGH (presiding). The committee will be in order.

The next witness is Dr. Walter R. Dornberger, technical assistant to the president, Bell Aircraft Corp.

Doctor, we are very happy to have you appear before us. It is a pleasure to welcome you.

STATEMENT OF DR. WALTER R. DORNBERGER, TECHNICAL ASSISTANT TO THE PRESIDENT, BELL AIRCRAFT CORP.

Mr. McDONOUGH. You may proceed, Doctor.

Dr. DORNBERGER. Mr. Chairman, and members of the committee and counsel:

I feel privileged to have this opportunity to talk to you about my ideas on space flight and to present my conception of the organizational requirements this country needs for the coming space age. These are subjects with which I have been concerned long before a sputnik appeared.

As you may be aware, I have had some experience in this general field, gained originally in Germany during the years 1930–45. I am

also aware that an organization such as operated during that period in Germany could not be applied here and would not work in the United States today.

I would like to begin by telling you something of the German operations, then explain my thinking on approaching the program of utilization of space by the United States for man, and finally, I will offer suggestions for a space organization effectively encompassing the interests of the scientists and military and other Government agencies. For the purpose of time, let us say that my remarks will be confined to what may transpire in the next 20 years.

The German interest in space flight was strictly military. That meant the Germans wanted to use very high altitudes and very high speeds in order to stay outside the effective range of conventional defense weapons. The German scientists and Government agencies, for the most part, were not interested at all in anything beyond the atmosphere.

When the effort was begun in Germany by the military establishments, all the tools available, such as powerplants and guidance systems, were primitive and of no use. There were many ideas and theories.

Ideas—we had lots of them, but everything else was missing. Since military importance was recognized, secrecy was our main concern. With the Treaty of Versailles in force, and the close international connections of our industry a fact, it was impossible to start such a project in public.

It had to be done in military establishments in all secrecy.

In 1930 at a time when I was a captain in the German Board of Ordnance—I was put in charge of what we call presently in the United States ballistic missile program, but at that time, was called rocket development. I was in charge of rocket development for the army and air force. The navy was not then interested.

The only one military requirement I ever got from my superior was very short, in all, eight lines. I received full responsibility and at the same time full authority to do the job as I saw fit. For the first years, I had to report only to the Chief of the German Board of Ordnance; from 1943 on, to the Chief of the German Military High Command, and from 1944, only to the Chief of the German Reich.

During World War II, the interest of the air force and the navy grew rapidly in this field and each started its own projects, but after a short time of what can be best described as highly organized confusion, a different approach became obviously necessary.

The first step was my assignment to what we could call in this country a guided missiles czar. All army, air force and navy departments associated with our projects were placed under my command. My field of operation was wide and included research and development, production, training of troops and supply of all three armed services. And, gentlemen, since we in Germany were then living under a dictatorship, there was never any question of the complete unification of the armed services.

Regardless of their basic service, all military and, for that matter, civilian personnel reported directly to me and I had the authority to promote, demote or fire them. There was no such thing as one of my organization reporting directly to a former superior.

By this concentration of effort on the part of all military services, any possibility of a duplication of effort was avoided. My entire staff, which had the responsibility for all missiles and solid and liquid fuel rockets, never numbered more than 150 men.

Our aims were weapons and weapons systems. Almost all research was applied research. Only approximately 10 percent of the research effort went into basic research. Since I did not have to ask anybody about what to do, decisions could be made fast and redtape was reduced to a minimum.

There was only one office in all the military establishments responsible for the entire program. That was my division; and since I gave trustworthy people enough authority to act, I was free for technical decisions, for planning and organization.

Since I remained in this position without even a thought of rotation for almost 15 years, the necessary steadiness in the development of such new weapons systems, which comprise in their design all branches of science and technology, was guaranteed.

Development work in the German guided-missile program was handled by the industry, which is the case in this country also, with one exception, the long-range ballistic missile. Here, research and development was done at Peenemunde, a strictly military establishment organized along the lines of a private enterprise. Salaries and wages equaled those paid by industry and the administrative setup was the same as in any private factory. Only a few officers held the key positions.

For the research and development done at Peenemunde, I should mention the fact that the military alone had the very expensive, the most appropriate and most modern facilities to get the job accomplished.

While most of the component development was done in the industry, Peenemunde did the preliminary design work, the weapon system work, the coordination, the assembly, testing, and firing.

In the research field, we first believed we should do everything on our own for security reasons. And only when time became an important factor did we call the scientists in to help us in the solution of specific problems.

It may be of interest to you to learn how this military establishment handled the ever-delicate question of relationship between the military and the scientist.

Frequently, at Peenemunde, it was necessary to obtain answers to problems encountered during the development phase of a weapons system planned for military purposes. We defined precisely, and in as few sentences as possible, the particular problem.

The scientists were requested to solve that problem and only that problem. They were never allowed to argue about it or to philosophize about the project in its entirety. An answer, clear-cut and to the point, in the shortest possible time, was what was wanted—and provided.

Scientists did not run our program, they just helped us.

Another facet which ran smoothly was budgeting. Since I was my own superior, a very unique circumstance, to be sure, this problem was much easier to solve then similar problems in this country.

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I was commander at Peenemunde and at the same time, division chief of all rocket development in Berlin. In this latter position I was also superior of the Peenemunde establishment and authorized to grant any amount of money needed.

It was easy for me to sign the annual check for Peenemunde, after I had argued with the people in Peenemunde about the amount.

Whether at Peenemunde or any other place, it is of the greatest importance for the success of advanced technical programs which run for periods of 5 to 10 years, or even longer, to be assured of sufficient funding on a sustaining basis. The yearly fight for the budget takes too much energy and time from key personnel who should be concentrating on technical matters and not devoting efforts on basic administrative problems.

Progress in any program recognized as necessary and vital should not be interrupted.

I hope that these preliminary remarks demonstrate that there can be no comparison between the status of a high priority project in Germany under a dictatorship during wartime conditions and the present situation here in the United States.

The beginnings of the space age at Peenemunde certainly have had tremendous influence on this subject by all governmental agencies, the industry and the military in this country.

But here in 1958, the problems of how to organize effectively for this technical new era are not simple by any means. However, I believe certain fundamental ideas can be well adapted for our present-day use.

First, and in my opinion this is mandatory, we must have a plan for what must be done first. Second, we must define how space can be best utilized for the national interests of the United States.

Let me cover the second problem first. Since 1942, when the first V-2 was launched, there has existed a fourth medium of travel, in addition to ground, air, and water.

A medium which can be used by man for different peaceful and military purposes. I refer, of course, to the medium of space.

I don't think I have to take time to enumerate the various ways in which space travel can be utilized. But, briefly, for the military, space flight means the expansion of the field of operations of the Armed Forces more and more into the vertical dimension; for our Government and for our Nation, space flight means prestige; for the scientists, a vast increase in knowledge in many exciting fields.

I believe that at present, and for the time period I am talking about, cislunar space will be the only new additional field of military operations. To really conquer, occupy, keep, and utilize this part of space during the coming 20 years should be the military's main interest and objective in space.

Anything beyond that, for the same time period, is only of political (prestige) or scientific interest.

I believe by accepting this thinking about the zones of interest, the areas in which each one should concentrate becomes easier to define. Cislunar space, which will become of tremendous importance for our national defense within the next 20 years, should be the main realm of the military, translunar space that of the scientist. When prestige is involved, the Government should decide which one should take the lead.

When the scientists have the responsibility, the military should help, and vice versa. No duplication of effort and facilities should be necessary or tolerated.

It is my personal opinion that space will be conquered and utilized by man and man alone—and not by automatic machines. Certainly, automatic probing devices have to precede manned flight into space. But only to obtain the scientific data necessary for later manned space flight operations.

We have to balance very carefully the high cost of automatic space devices with the gains reasonably to be expected.

Looking at space flight and the utilization of space for our national interest, I think we should be aware that three fundamental prerequisites are necessary:

(1) The question is no longer one of sending several thousand pounds into orbit or several hundred pounds to the moon, but rather to get 20,000 or 30,000 or more pounds at a particular spot in cislunar space. In order to achieve this, we urgently need the development of high thrust powerplants, able to deliver substantial tonnage into space. High energy propellant and nuclear powerplants should have top priority. And to expedite quick results we should make up our minds what type of high energy propellant is the most desirable and concentrate on it.

(2) Space will be ours only when we are able to maneuver in it. That means the ability to change our course and to increase or decrease our speed at will. In order to avoid excessive takeoff weights and highly complicated overall systems, we need:

(*a*) a lightweight space engine for which the necessary energy will be taken out of space, for example ion rockets. Ion rockets are still in the laboratory stage, but we need them urgently.

(*b*) we need an on-board navigation and guidance system by which we know at any time where we are, where we are going and at what speed. We cannot wait during a flight until ground stations or a system of artificial satellites tell us where we are. This navigation system has to be coupled with a sub-miniaturized computer, so that the necessary corrections can be made according to the reasoning power of the man. Up to now, this navigation system does not exist.

(3) We must solve in practice the problem of a safe return to a predetermined landing strip after a flight through space. I think it is foolish to start with a flight to the moon and then try to come back. We should use a step-by-step approach, going higher and faster every time and making sure that our crews will come back safely to earth. We have theories enough, but have none proven yet in practice. This problem area should be another main concern in the coming years.

All other problems of space flight are of relatively minor importance and will be solved without requiring any additional major scientific or technical breakthrough.

Now, may I discuss some basic principles for our planning—planning which will give us a clearcut, expeditious program for the conquest and utilization of space.

In 1942, the Germans had conceived by a step-by-step approach, and many of its aspects are still valid today.

A certain overlapping in the development of different steps will be necessary, especially in view of the increasing time for development

of each succeeding step. Applying this realistic step-by-step approach to usable space vehicles as a guide, all necessary research effort and the development of needed component parts can be initiated on time, and all more or less fancy and premature projects can be eliminated.

Now as to my conception of a step-by-step plan for space flight, I must acknowledge that some preliminary phases are already under way. But for the purpose of illustrating what I consider an orderly plan, I would like to list these steps:

1. Automatic single-stage ballistic rockets, as for example the V–2 and the Redstone.
2. Automatic single-stage rocket glider, such as the A–9 in Germany.
3. Manned single-stage rocket gliders such as the German A–9B and the United States X-series, the X–1, X–2, X–15, and so on.
4. Automatic multistage long-range ballistic rockets such as the Atlas and Titan.
5. Manned multistage, long-range hypersonic rocket gliders like the Dynasoar series.
6. Automatic satellites, such as the sputniks, Explorers, and Pied Pipers.
7. Manned ferry rockets to a satellite orbit, extending up to the moon.
8. Manned satellites, recoverable or permanent.
9. Automatic space vehicles.
10. Manned space vehicles.

I think we are well on our way to the automatic satellites. First prototypes are up in space, bigger ones will follow. I am quite sure we will soon solve the problem of accuracy, but since these bigger satellites will stay in space over quite a period, months or even years, and spaceships will be on their trips for weeks and months, we may not be able to solve the problem of reliability. No automatic, complicated, unattended device such as a large satellite will work satisfactorily in space for the operational time we are talking about.

With the high costs of these satellites, we have to get human beings up to adjust, repair, and to exchange the equipment, and we have to get the crew back. The same problem arises when we have to use the moon as a satellite. Therefore, the next natural step after the big satellite is a ferry rocket to deliver the crew and the material to any permanent satellite orbit and get the crew back.

Other problem areas which should be included in our planning is our armanent in space. This will be of major importance since many weapons used in the atmosphere won't work effectively in space.

Another problem will be space technology. Our equipment is built most of the time for terrestial use. In space, there is a different environment in which this equipment has to work. All conditions in space cannot be simulated on the ground. We have to get up in space with a kind of flying testbed or flying space laboratory, to make our investigations conclusive.

In my opinion, the Dynasoar program, which the United States Air Force has under consideration now, will help us tremendously in this respect. It merits all the support it requires.

Space flight is of the utmost importance to the future of our country. And in our efforts to conquer this medium of travel, we must not let ourselves be panicked into undertaking new projects before we have solved the challenges of the preceding step.

I do not mean to say that development of main components has to be on a concurrent basis. But I am opposed to "wild blue yonder" schemes which could divert us from the more vital business at hand.

I am also opposed to setting up an all-out crash program to conquer space with spaceships right now. Too many unknowns are still existing. We have to create first of all the tools we probably need. A realistic step-by-step approach is better than rushing ahead forcefully and then later having to retrace our steps.

Now, how can we organize for the coming space age here in this country?

Two main principles should govern us:

(1) Any duplication of effort must be avoided.

(2) Someone, preferably an individual, has to make the final decisions.

Several groups are concerned with space conquest.

There is the interest of the scientists, who want to explore space in order to increase scientific knowledge, there is the interest of the Government, for example, the Department of State, which wants to increase our national and international prestige, and there is the interest of the military, who may have to fight wars in and out of space.

These interests are bound to collide.

There must be an agency with distinct power for decision on the very top, even at the Presidential level.

Such a Space Agency could perhaps be directed by another Vice President. I am told that the President might use more Vice Presidents to help him run the country and a Vice President of Space could be a good office to start expanding the second level of our national administration.

Of course, you understand I say this to help illustrate how important and how high in the administration I think my suggested authority on space matters should be.

This Agency would give the green light for any major space project, would decide who should run projects which may be needed, for instance, only needed for national prestige reasons.

This Presidential Space Agency would also coordinate the efforts of any or all other agencies interested in space. These would include the Secretary of Defense, and if you will permit me to envision for a moment, perhaps even a Secretary of Science.

According to my ideas, a Secretary of Science could effectively and justifiably be the organizational head of the National Science Foundation, National Academy of Science, and other scientific establishments.

The Space Agency at the Presidential level would have the full authority of decision making, not just an advisory function alone. It could be small in size, since no studies should be made by this group.

Research facilities should not be duplicated. I think that the plan to expand the field of the National Advisory Committee for Aeronautics to take care of space research also is an excellent idea. But this new National Aeronautics and Space Agency, as recommended by the President, should not try to develop its own space vehicles or to run projects. NASA should serve as a basic and applied research facility only, and should serve the scientists as well as the military. It should have no authority to decide about a project.

Direct and close cooperation between the two main scientific and military agencies and the expanded NASA is mandatory. But any difference of opinion between these agencies which are to lead the United States into the space age, should be straightened out by the Space Agency on the Presidential level.

In their field of interest, the Secretary of Defense, as well as my suggested newly to be established Secretary of Science, should have full authority.

And as just a word of caution—or precaution. In each department, that of defense and of science, there will be dozens of subdepartments and suboffices which will want to have an important word on the space age.

These departments and offices should be held to a bare minimum, if not eliminated from a voice at all.

Time and well-conceived action, not words and paperwork, are the main considerations now.

I am convinced that with close cooperation between the two main participating agencies and the NASA, duplication of effort can be avoided, and steady progress made toward a dominant role for the United States in the space age.

Thank you.

Mr. McDONOUGH. Doctor, judging by questions and comments made by members of the committee during the hearings that have been held to date, it is evident to me that quite a few of the members, if not all—though I am not speaking for all—appreciate the significance and importance of your recommendation about a Department of Science.

Any bill that is reported that does not provide for the establishment of a Department of Science will not be because the members failed to recognize the significance of your testimony and others in that respect, but due to the separation of powers that we have under the constitutional government.

While Congress could force through a law establishing a new department, it would be a matter of wisdom whether that should be done until a President, whoever might be in the White House, was willing to recognize the fact that such a department, or any new department, should be established.

You understand that.

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. Profound consideration by Members of the Congress should be given to the views of the President in all matters, particularly with respect to enlarging the President's Cabinet. Even without the Cabinet status by law, the President can invite one to sit in with the Cabinet and to occupy what, in effect, would be Cabinet status. So, if we report out a bill that does not go that far, we would not want you or other witnesses to think that we are ignoring your views and your opinions in that respect.

However, there are other factors that face us under our constitutional setup which you appreciate, I am sure.

Dr. DORNBERGER. Mr. Chairman, I am 100 percent with you. My proposal basically is merely to put an organization within the organization that we have. An additional and special organization to concentrate on space. It matters little what name this organization

bears as long as its function is clearly defined. I am not suggesting changing the constitutional organization in this country.

Mr. McDonough. I think, in my mind, it is just in the future, it is just a matter of time, when there will be a Department of Technology or some similar department.

Mr. O'Brien.

Mr. O'Brien. Doctor, I want to compliment you on your very fine statement. I understand in the fraternity, you are considered to be the "elder statesman," so we should regard carefully what you have said. You have made it clear that you believe the director of this Space Agency should hold an exalted position, very high in the Government. Do you have any ideas as to the type of man who should fill that exalted posititon? Should he be a scientist?

Dr. Dornberger. Not necessarily. He doesn't have to be either a military man or a scientist.

He should be a man with a lot of experience, a lot of commonsense, a man who is able to understand the language of the scientist, to set goals to the scientist and to supervise scientists, a man who is able to run, administratively, very difficult jobs, and a man who understands and can fulfill fiscal requirements and can secure essential funds.

Mr. O'Brien. He would have a great deal of authority over the military, too?

Dr. Dornberger. Yes. The man I propose in my organization should have complete authority. Since we will have different departmental interests, such as the military, scientific, commercial and communication, we must have a man at the very top able to make decisions when and if interests collide or duplication of effort is evident.

For instance, the Secretary of Defense is primarly interested in military applications. The Secretary of Science, or the scientific departments, are naturally concerned only with scientific achievements or those achievements which contribute to national prestige. Serving both of these organizations, purely from a research standpoint is the NASA. The scientific and military interests unquestionably would collide. NASA should not have the authority to intervene except in research matters. There must be a higher authority, someone on top to make the final decisions. There could be no efficient setup for a space agency which does not have authority at the Presidential level.

Mr. O'Brien. I notice you stated that in the project which you headed, approximately only 10 percent of the research effort went into basic research.

You saw the urgency of the problem at that time as being a military problem.

But it would be your idea that the director would be the one to decide at a given time as to what percentage went into basic research.

Dr. Dornberger. Yes.

Mr. O'Brien. I would assume that times being as they are now, that 10 percent would be probably a small percentage. It would probably be something larger than that.

Dr. Dornberger. Before answering the question, I think we should define what is basic and what is applied research.

Personally, I think when our problem is primarily to get into space, then all research work for this purpose is applied research.

Mr. O'BRIEN. I notice that you mentioned that you remained in your position for 15 years, or almost 15 years, without any thought of rotation. Do you believe that this high official should have a long term, too?

Dr. DORNBERGER. Yes. I think so. As an example, I refer you now to Gen. Bernard A. Schriever, commander, Air Force Ballistic Missiles Division. General Schriever has been in his position for about 4 years and it is reported that he is eligible for reassignment. A man barely gets acquainted with the problems of a position such as his in 4 or 5 years. Abruptly we transfer all of his experience and substitute a man who can be completely new in the field. He may have new ideas, a new philosophy and may change many things detrimental to smooth progress. In such an important job, tenure is almost as important as experience.

Mr. O'BRIEN. Our primary job here, as I understand it, is to get this Space Agency off the ground. I think that we are concerned with the powers that it would have. But would you not think that first we should create a strong agency, with a responsible man on top or a man with full responsibility at the top? Then, on the basis of their first year of operation, perhaps, consider your other point concerning the continuity of appropriations?

I noticed you made quite a point of the hit-or-miss business on appropriations. You would not suggest that we try, in writing this legislation, to cover that whole subject at this time; would you?

Dr. DORNBERGER. Well, not necessarily. However, we must keep in mind that the projects we are talking about can run into decades before they are completed and continuity and funding is a prerequisite.

I would like to make a further comment about NASA, which is the only logical research organization in the Space Agency, as I see it. NASA should be the one and only research organization, with the best and most extensive facilities available. But it should be a research organization only and should not do development work of its own.

If NASA were to do its own development work, as proposed in this bill, there is a possibility it could concentrate its efforts entirely on its own conception of space travel. This conceivably could eliminate its consideration of the projects of other interested agencies. If NASA is to be a true research organization, it should stick to research and provide research for all the developmental agencies—a big enough job in itself. Otherwise, we will find ourselves in the position of having the developmental agencies doing their own research as well as their own hardware.

Mr. O'BRIEN. I have one other question. We have had some discussion from time to time about the desirability of feasibility of sending a manned rocket into space for 150 miles. It has been suggested. I notice you said you think it is foolish to start a flight to the moon and then try to come back, but you should use the step by step approach. I am inclined to agree with you. Do you think it would be a stunt like shooting a woman out of a cannon to experiment first with sending a man in a rocket, say, 150 miles in the air and getting him back?

Dr. DORNBERGER. No; I think not. In an effort such as this we may secure some data which can be used later in the conquest of space or

for establishing systems in space. However, this seems to be of a one-shot matter and we should do it only under the condition that the costs are reasonable. That means that if we can use available hardware, with a cabin of some type for the man, we might try it. But to develop an entirely new device just for that purpose, and unquestionably spend millions of dollars, I think, then, this would be a waste of money.

Mr. O'BRIEN. I have one final question. I notice you are technical assistant to the president of the Bell Aircraft Corp. The president of the organization is a very close and old friend of mine. I was wondering, is industry, as represented by such corporations, ready to move step by step with this proposed agency when they outline their recommendations?

Dr. DORNBERGER. I think so.

Mr. O'BRIEN. Is it not a fact that in many phases of this space problem, industry is farther along than many of us realize?

Dr. DORNBERGER. With ideas, yes.

Mr. O'BRIEN. With ideas? I understand; yes. But you feel that industry can perform any function that this Agency will handle?

Dr. DORNBERGER. The whole question of space, in my opinion, is no longer a scientific question. We don't need any major scientific breakthrough. It is basically now an engineering problem, and I think our industry is capable and willing to make a realistic approach to the problem. Furthermore, I think we can do it.

Mr. O'BRIEN. Thank you very much, Doctor.

Dr. DORNBERGER. You are welcome.

Mr. O'BRIEN (presiding). Mr. Metcalf.

Mr. METCALF. You have based your whole statement upon the creation of a Secretary of Science. The chairman has discussed with you why it would not be feasible at this time to create a Secretary of Science. But we have this proposal to expand the NACA into a larger agency, the NASA. You say that this Agency should have no authority to decide about a project. Suppose we do not create a Secretary of Science. Who would have the authority to decide about a project?

Dr. DORNBERGER. The question of space is so important that all decisions should be made at the Presidential level. And this would apply whether we have a Secretary of Science or not.

Mr. METCALF. A director?

Dr. DORNBERGER. A director would be a good title. I am against committees and commissions and, if it isn't possible to set up a Secretary of Science parallel to the Secretary of Defense, with a Presidential space agency on top of this, then it may be necessary to give the Director of NASA authority to make decisions. But, as I have tried to explain, I am a little scared of what may happen in a couple of years when this Director might say: "I see no reason why there should be a manned reconnaissance satellite. As Director of NASA, I want top priority for a communications satellite which may reflect radar and radio signals. Furthermore, I want 3 television satellites established at an altitude of 23,000 miles so that we may service the entire globe and will be able to give the people of the entire world the TV programs of the United States."

This may be a little exaggerated example, but, if it should happen, we could not get research effort out of the NASA for military proj-

ects because the money available for the NASA would be used to do the jobs which NASA thinks should have top priority. Under such circumstances, I see the possibility of a collision of interests.

Mr. METCALF. You suggested that we are going to have to build in this step-by-step program, not too much to get machines or automatic devices into space, but to get men into space.

Dr. DORNBERGER. Yes.

Mr. METCALF. Have you ever made a proposal or a suggestion for getting man into space?

Dr. DORNBERGER. My proposal was the Dynasoar proposal, made in 1951 under a different name.

Mr. METCALF. Would you give us some background on that? To whom did you make that proposal?

Dr. DORNBERGER. That was made to the military, to the Air Force. It was finally accepted as a line proposal after 7 years. We could now fly with a man around the globe if we had started in 1951.

Mr. METCALF. Was NACA consulted, or the Director of the NACA consulted in that proposal?

Dr. DORNBERGER. NACA was working with us in doing some studies and research work.

Mr. METCALF. And concurred in this proposition?

Dr. DORNBERGER. They concurred in the proposition; yes.

Mr. METCALF. It was turned down by the military?

Dr. DORNBERGER. There wasn't money available.

Mr. O'BRIEN. Mr. Natcher.

Mr. NATCHER. Doctor, in your statement, you stress that research facilities should not be duplicated. I certainly agree with you, and I think every member on the committee agrees with that statement. You further state that:

> I think that the plan to expand the field of the National Advisory Committee for Aeronautics to take care of space research, also, is an excellent new idea. But this new National Aeronautics and Space Agency, as recommended by the President, should not try to develop its own space vehicles or to run projects. NASA should serve as a basic and applied research facility only, and should serve the scientists as well as the military.

Doctor, under the bill that we have before the committee, that we are studying now, on page 1 of this bill we have a declaration of policy. I want to read this to you, and see if you, in your mind, find any conflict with your statement and our declaration of policy.

That is on page 1, Doctor; Section 2: Declaration of Policy.

> The Congress hereby declares that the general welfare and security of the United States require that adequate provision be made for research into and the solution of problems of flight within and outside the earth's atmosphere, and that provision also be made for the development, testing, and operation for research purposes of aircraft, missiles, satellites, and other space vehicles, manned and unmanned, together with associated equipment and devices.

Doctor, is that vesting too much authority in the Space Agency?

Dr. DORNBERGER. No. I agree with it a hundred precent.

Mr. NATCHER. In other words, there if no conflict, then?

Dr. DORNBERGER. No. But I disagree with page 6, line 1.

Mr. NATCHER. Page 6, line 1.

Do. DORNBERGER (reading):

> Develop, test, launch, and operate aeronautical space vehicles.

Mr. NATCHER. In your opinion, Doctor, that should be stricken out?

Dr. DORNBERGER. Yes.

Mr. NATCHER. It should be stricken?

Dr. DORNBERGER. Yes.

Mr. NATCHER. In your opinion, you don't believe that the new agency should have that authority?

Dr. DORNBERGER. That is correct.

Mr. NATCHER. Now, I would like for you to explain to the committee a little more in detail as to why, Doctor.

Dr. DORNBERGER. A scientific research organization with the authority to develop its own projects will tend to back its own projects, exclusively. I saw the same kind of organizational setup in Germany fail dismally. There has to be unity between all interests, but a research organization is not the answer.

It is supposed to supply research, know-how, and facilities. Supposing the Secretary of Defense was concerned with getting a reconnaissance satellite up to an altitude of 100 miles, where he could get the type of information pertinent to the Military Establishment. Perhaps information even from behind the Iron Curtain. Conceivably, the NASA could say: "We are not interested in that. We are developing a communications satellite, and all our efforts and facilities are being devoted to that."

If we ever get put in this position, who is going to decide the relative importance of the projects? I say don't let a research agency do development work. They may help in the development done by others after a decision has been made at a top level. But the research agency should have no authority to make a decision.

Mr. NATCHER. Doctor, do you find any other provision of this bill that you would like to call the committee's attention to, that you disagree with, or do you have any advice——

The CHAIRMAN. Might I ask a question there?

Mr. NATCHER. Yes, Mr. Chairman.

The CHAIRMAN. I assume this is in connection with research and development that comes within the jurisdiction of this Agency. You would have some civilian agency have that power?

Dr. DORNBERGER. A civilian agency. I agree a hundred percent.

The CHAIRMAN. Who?

Dr. DORNBERGER. An expanded NASA should run the research facility.

The CHAIRMAN. What about "develop, test, launch, and operate?" You said you wouldn't put that there.

Dr. DORNBERGER. That is under my Secretary of Science.

The CHAIRMAN. Suppose we don't have a Secretary of Science?

Dr. DORNBERGER. That should be done by the National Science Foundation or National Academy of Science.

The CHAIRMAN. They have already testified that they would not.

Dr. DORNBERGER. They should, or another organization interested in space ships for scientific, commercial, or prestige reasons should handle the scientific phases.

The CHAIRMAN. There should be cooperation to some extent. Well, some civilian agency ought to have this power?

Dr. DORNBERGER. Yes. I agree.

The CHAIRMAN. All right.

Mr. NATCHER. Doctor, are there any other provisions in this bill that you would like to call to our attention?

Dr. DORNBERGER. I think when you strike No. 1 on page 6, then on page 7, line 7. If you do that, then you have to follow through.

Mr. NATCHER. Let's see, Doctor. On page 7, which line?

Dr. DORNBERGER. Paragraph (3), "To acquire, construct, improve, repair, operate, and maintain laboratories."

That is all right with me.

"Research and testing sites and facilities."

On testing sites, I would say "No;" "manned and unmanned aeronautical and space vehicles," that I would strike.

Mr. NATCHER. Doctor, assuming that this bill or a similar bill is enacted into legislation by the Congress of the United States, the NASA will take over the duties, powers, and functions of the NACA.

The NACA has about $500 million worth of property and 7,600 employees.

The provision there is a matter of taking over of the present existing agency. Do you object to that?

Dr. DORNBERGER. No; to the contrary. But the NACA up to now has not developed one single airplane. The airplanes were developed by the civilian organizations, by the commercial organizations, or by the military.

The NACA just tested some of them, did research work with some of them.

Mr. NATCHER. Thank you very much, Doctor.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Doctor, I hesitate to take the time to go back over this. I would like to clarify, in my own mind, a little bit further, just who will have the authority to make the final decision. On the bottom of page 11, of course, as has already been called to your attention by the gentleman from Montana, you state that it should have no authority to decide about a project. You are referring to the NASA?

Dr. DORNBERGER. Yes.

Mr. SISK. On the top of page 12, you go ahead and state in the first paragraph that:

> Direct and close coperation between the two main scientific and military agencies and the expanded NASA is mandatory.

I think certainly we can all agree on that.

> But any difference of opinion between these agencies which are to lead the United States into the space age should be straightened out by the space agency on the Presidential level.

How you would differentiate between that and what you said at the bottom of page 11 is what I am talking about.

Dr. DORNBERGER. In order to clarify my opinion of the importance of decisions on space, I mentioned first that I thought of a kind of vice president of space, or space agency reporting directly to the President. This would be a court of last appeal on space questions. And when it comes to decisionmaking or execution, then the President or the agency at the Presidential level, should have the final word. There must be someone or some agency not directly related to the military, scientific, commercial, or research organizations who would make final decisions.

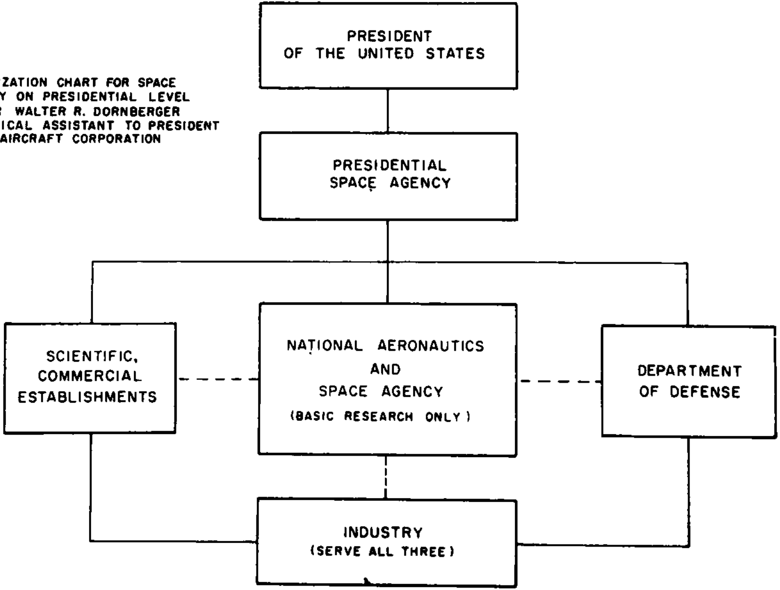
Mr. SISK. I understood your desire, of course, for either a vice president in charge of science or a secretary of science. In fact, frankly, Doctor, I have rather leaned in that direction myself at times.

But the only question, and I understood your recommendation is when you refer to the space agency on the Presidential level, I just wanted to get clear in my mind actually to whom you were referring in that instance.

Dr. DORNBERGER. May I draw you a sketch of my conception of a space organization.

(The chart referred to above follows:)

ORGANIZATION CHART FOR SPACE
AGENCY ON PRESIDENTIAL LEVEL
BY DR WALTER R. DORNBERGER
TECHNICAL ASSISTANT TO PRESIDENT
BELL AIRCRAFT CORPORATION



Mr. SISK. Thank you, Doctor. I think this certainly clarifies in my own mind your thinking. Then, as to how these various agencies will fit together. That was the thing that, frankly, I was having a little difficulty with. I think this certainly does clarify it. I thank you very much for it.

I might say, Mr. Chairman, that we might get the Doctor to place this in the record, along with his remarks, which I understand we will have an opportunity to expand and correct.

You have the right to edit your remarks, to go over them, in other words, and add or clarify them in any way you want to, Doctor.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Dr. Dornberger, you have had a vast amount of experience in this rocket propulsion. Your advice and counsel here are very welcome and very much appreciated.

You evidently believe in a straight line of command, with authority at the top, and with duplication held to a minimum, all of which is good management. We hope we can find a way to do that.

In your position in the Peenemunde project, do I understand from your statement here that you reported direct to the head of the German Reich?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. That was to Hitler?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. You had no limitation on the funds, you were given a free hand to operate and so forth?

Dr. DORNBERGER. Yes. I was further told: "If you succeed, we will place the highest decoration we have in Germany around your neck. If you don't succeed, you will have a noose around your neck."

Mr. McDONOUGH. What background did you have for such an appointment previous to this?

Dr. DORNBERGER. I was an active officer of the German Army, but I went to college as a captain in the German Army and studied for 5 or 6 years and got my degrees in mechanical engineering and my doctor's degree in engineering. Then I came back on the Board of Ordnance and I was asked to take over the rocket development, and I had to do it.

Mr. McDONOUGH. In other words, your mechanical——

The CHAIRMAN. You said you had to do it?

Dr. DORNBERGER. I had to do it; yes.

Mr. McDONOUGH. In other words, your education in mechanical engineering was a great asset?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. At that time you had nothing on astrology, meteorology, or astronautics?

Dr. DORNBERGER. No. As a military man, you have quite some experience in treating people, and you succeed as an officer only if you can put the right men on the right spot. It is the same in the industry. I think my studies at the technical university in Berlin helped me to put the right engineers on the right spot, and the right scientist on the right spot.

Mr. McDONOUGH. You were very fortunate. How many failures did you have in the V-2 rocket before you had a successful rocket?

Dr. DORNBERGER. We had two failures before we had the first successful flight, and then we had 36 before the next successful flight.

Mr. McDONOUGH. Two before the first and thirty-six before the second?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. Do you mean that after the 36th failure you were able to hit the target pretty accurately?

Dr. DORNBERGER. No; not accurately. At that time, the guided system did not work so good. After we started firing in the first year, we had an overall reliability of approximately 30 to 40 percent. When we went into operation, we had overall reliability of approximately 75 percent. At the end of the war, we had an overall reliability of the V–2 of 78 percent.

Mr. McDONOUGH. You studied only the project of propelling a rocket into space with a warhead on it to hit at a designated target?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. At what elevation did you shoot the highest rocket?

Dr. DORNBERGER. Usually we fired with 45° elevation at the burning cutoff point. With a shot fired vertically, we obtained an altitude of 125 miles.

Mr. McDONOUGH. 125 miles?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. Of course, you understand that your recommendation for a vice president of space would require a constitutional amendment in this country?

Dr. DORNBERGER. I don't think so. You have a Vice President. Why don't you give him this additional work to do?

Mr. McDONOUGH. Put him up in space, do you mean?

Dr. DORNBERGER. No.

Mr. McDONOUGH. He is covering a lot of territory right now on earth as it is. I don't know whether we can get him off the ground or not.

I noticed that in your statement you said whatever followed was over a period of some 20 years, and that you believed that the first objective was to develop the basic research on space technology and apply it as we go along.

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. And that we should not do anything spectacular because, perhaps, on the other hand, the Russian people may do such a thing for propaganda purposes and we should not be disturbed about a thing like that.

Dr. DORNBERGER. We should not be. But, on the other hand, if, for prestige purposes, we need such a thing, and if we can achieve it by using available hardware, I would say yes, we should do it.

Mr. McDONOUGH. When you say 20 years, what, in your opinion, with a concentrated program, with the elimination of as much duplication as possible, in what period of time from now on could we put a man in space in a manned space vehicle to go into cislunar space and return to earth?

Mr. DORNBERGER. I think that a man can fly around the globe within 1½ years, but we are not quite 100 percent sure if we can get him back where we want him. But to get a man up in space, or even a

crew, to fly around the globe up to 7 times and land at a predetermined landing strip is the real problem. This will take approximately 4 to 5 years.

Mr. McDONOUGH. Do you think that we are making as much progress as we can make with the scientific manpower we have in this country and the industrial know-how?

Dr. DORNBERGER. I have no doubt that the scientific manpower needed is available. The problem is only that we lose too much time before we start something.

Mr. McDONOUGH. How long do you think it will take us to develop a half million pound thrust engine?

Dr. DORNBERGER. It will take 2½ years, to get it reliable.

Mr. McDONOUGH. We are working in that direction now.

Dr. DORNBERGER. Yes; but that is not enough.

Mr. McDONOUGH. No?

Dr. DORNBERGER. We need much more thrust.

Mr. McDONOUGH. Will it take 2½ more years to develop a million pounds thrust?

Dr. DORNBERGER. It will take 3 years or 3½ years to develop a 1 million-pound-thrust engine. But I only hope that the 1 million-pound-thrust engine will not be based on conventional propellents, but that we will immediately go to high energy propellents.

Mr. McDONOUGH. As I understand your recommendation here, you believe that this Agency should develop basic research, and approach up to the point of experimentation, and from there on cease to operate?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. It should go over to private industry from that point?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. They should write specifics, outline procedures, and inform industry what they want after they have thoroughly tested it and found that it is practical?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. That is a very good thought. Thank you.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. I will yield to Mr. Ford, who has been continually last.

Mr. FORD. The main thing I get from your testimony, Doctor, is that you believe there should be a strong director who will have very few restrictions on the administration of the program. That was your experience during World War II and that is what you think would be most effective for this kind of an organization. As I read the bill which has been submitted, in effect that is what is aimed at, although there is an advisory board composed of 17 members.

You do believe that in this kind of an agency, even though it does not coincide with the area that you are proposing generally, that there should be a director, such as is recommended here?

Dr. DORNBERGER. There should be a director. But the makeup of the man is the most important.

Mr. FORD. How do you feel about a board of directors as envisioned here?

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Dr. DORNBERGER. I think there should be a director. I think also there could be a board numbering 17 members as outlined in the bill. The board should act only in an advisory capacity. The authority would be selective, to make final decisions should be vested only in the director.

Mr. FORD. You prefer the director type in contrast to the commission type, where you have 3 to 5 to 7 members?

Dr. DORNBERGER. I certainly do.

Mr. FORD. Thank you very much.

Mr. FULTON. We are glad to have you here, and we think you have done fine work. I like your approach, going step by step with about 10 or 12 steps being proceeded upon at the same time, some of short duration and some of longer time. That is what you have in mind, is it not?

Mr. FORD. Yes.

Mr. FULTON. There are various projects, each of which would begin now, but which might have a longer time of fruition.

I was amused at the exchange between you and my good friend from California on astrology. Astrology, of course, is the science of the stars as to their effect on human beings, when they are born, when to plant, and when to do other things, while astronomy, of course, is more of the science of the stars.

I don't think either of you meant you were proceeding on any basis of astrology in the space field; did you?

Dr. DORNBERGER. No; I am not. I am a little bit more realistic. I don't know what will happen in space or for what we will use space. I am sure nobody knows. But I think we should go out and find out.

Mr. FULTON. There is this possibility, that we can use space to benefit mankind. For example, we have present circulatory diseases, diseases caused by air pressure, even heart diseases.

The hospitals of the future might be in outer space on things like heart diseases.

Dr. DORNBERGER. I agree with that. We may find things in space that are absolutely of no use to us. There may be other things which will be greatly to our advantage. But before we try to determine theoretically what exactly exists in space, I think we first should go up into space. We may find there are hazards whose existence we are unaware of and there may be other things which will prevent us from doing many of the things we believe now we can do.

Mr. FULTON. And we may find that the rate of cell development is controlled in some degree by the position you are in in outer space.

We may have various locations for various diseases, or for growth, or for young people or old people.

Dr. DORNBERGER. I agree.

Mr. FULTON. We might have an old person's home, then, in outer space.

I agree with you that nuclear propellents are the prime point to be considered on our development of space vehicles and space missiles. I think that is an excellent point, that you say it should come first as a prime factor.

You would stress that?

Dr. DORNBERGER. Yes; it should come first. As I indicated in my remarks, Germany had at least the same basic ideas about space as we have in this country but Germany at that time didn't have the tools until they developed a highly efficient powerplant and followed this with the development of the required guidance system. But even the tools they had were not sufficient to allow them to go into space. Despite the fact that we don't have in this country all the tools and all the knowledge, there is still considerable talk about space vehicles and how soon we will go into space. To expedite our entry into space, I think we should develop the tools and, of course, I mean propellents and guidance and so forth now, without even fully knowing for what purposes we would use them later.

Mr. FULTON. We have a man named Admiral Rickover who has adapted nuclear-power propulsion to submarines which operate in the medium of water.

It is fairly well along on development now, so that it is merely the flattening out of the curve of progress. Why not take a man like Admiral Rickover over into the Space Agency and say, "Look, get on the nuclear propellents in outer space."

He did a pretty good job on the submarines. Would you recommend such a thing immediately?

Dr. DORNBERGER. The type of directorship such as held by Admiral Rickover is what I would propose.

Mr. FULTON. But we would need the kind of a man who has perseverance to put a program over for outer space; would we not?

Dr. DORNBERGER. Yes.

Mr. FULTON. May I finish with this? I have often wondered, coming from a coal-mine country, when there were mines around Peenemunde, why didn't you put the Peenemunde installation in the coal mine.

Why was it so unprotected on the surface? If it had been around Pittsburgh, we would certainly have had it in a coal mine.

Dr. DORNBERGER. Well, that is a good question. However, you probably know the Secretary of the Air Force we had at that time. He made a statement that his name would be Meyer if there ever was an enemy airplane over the area. Of course, we began calling him Meyer in 1941. I think Peenemunde itself, along with the atom bomb, was one of the best kept secrets of the war. We started at Peenemunde in 1937 and even by 1945 American-British intelligence still didn't know the names of the leaders at Peenemunde.

Mr. FULTON. The Russians weren't able to get anything about Peenemunde, were they, but they were able to get some of our atomic secrets 6 months after they were told to get them? The Russians never got anything from Peenemunde, did they?

Dr. DORNBERGER. No.

Mr. FULTON. Thank you. You have been a good witness.

The CHAIRMAN. Mr. Ford.

Mr. FORD. Doctor, what is the definition of cislunar?

Dr. DORNBERGER. Cislunar space is the space between the moon and the globe, a distance roughly of 286,000 miles.

Mr. FORD. Anything from here to the moon is cislunar?

Dr. DORNBERGER. Yes; and beyond the moon is translunar.

Mr. FORD. Translunar?

Dr. DORNBERGER. Yes.

Mr. FORD. Thank you very much.

The CHAIRMAN. Mr. Feldman?

Mr. FELDMAN. Doctor, can you contrast the power to make decisions that you enjoyed in Germany and which you have described already with what you found in the military organization of this country?

Dr. DORNBERGER. Here in this country when the missile and rocket programs began to develop, too many offices, departments, and divisions, to say nothing of committees, sought to have voices in these matters. Already it is evident the same situation is developing in the field of space.

I think one office is sufficient. One person in one office in the Air Force, in the Army, and in the Navy should make preliminary and final decisions and should be able to handle all problems, big or small.

Now there are 20 or 30 offices in different locations in the country and when you propose a project, generally you have to run through all 20 or 30 offices. This can take a proposal 2 years to complete and then when you are through, you start all over again because officers in charge of the various military departments usually rotate every 2 years. This can be really frustrating.

Mr. FELDMAN. You stated also that you presented a plan for a space ship in 1951 and it was not started until 1957 or 1958—7 years later. What took place in between the time of your original proposal and 1958?

Dr. DORNBERGER. I can tell you what happened. I made 678 presentations about that project to all the different military offices involved in all parts of the country.

Mr. SISK. Will the gentleman yield? Did I understand that he made 678 presentations of this particular project?

Dr. DORNBERGER. Yes.

Mr. SISK. Over a period of how long, Doctor?

Dr. DORNBERGER. Seven years.

Mr. SISK. Thank you.

Mr. FULTON. During what period?

Mr. FELDMAN. 1951 to 1958.

You spoke of the fact that it would take 3½ years to develop a space ship which would circle the earth several times and then arrive at a predetermined spot. Did that contemplate a program which might be delayed through lag or the kind of barriers that you encountered previously?

Dr. DORNBERGER. No. I think the main reason is, you know, the shirt is always a little bit closer to the body than the jacket. At that time we were at the point when we had to fight the Korean war with the weapons we had, and the feeling was that we had to mass-produce these weapons, which were still superior to the Russian weapons. At that time money was spent in that kind of weapons systems and there was not enough money to start an expensive new project, such as putting a man in space. I can understand the attitude of the military. But with a little bit bolder approach, we would have been much farther now.

Mr. FELDMAN. I think you misunderstood my question. My question is this—I believe in response to a previous question, you were

asked how long it would take to develop a space ship now. You said to develop the kind of a space ship which would circle the earth several times and then land at a predetermined spot would take 3½ years.

Dr. DORNBERGER. Let me restate it. First, to send a man around the globe, without knowing exactly where he would come down, would take 1½ years. But to send a ship into space with a crew of two, which would circle the globe perhaps up to seven times and then come back to a predetermined landing strip so that the ship could be reused, will take 3½ to 5 years.

Mr. FELDMAN. I misunderstood you. But using that as a hypothesis to this question, does that contemplate a green light to go ahead and start on such a project at that time, or is such a project underway at this time?

Dr. DORNBERGER. We are waiting for the green light now. As far as I know, the decision will be made in the next couple of days.

Mr. FELDMAN. You feel confident that you can accomplish what you said you could accomplish?

Dr. DORNBERGER. I feel confident that such a project could be accomplished.

Mr. FELDMAN. How seriously do you regard this whole problem of conquering space?

Dr. DORNBERGER. I think it is very important.

Mr. FELDMAN. Would you call it a life and death struggle?

Dr. DORNBERGER. It is a life and death struggle of our Nation.

Mr. FELDMAN. Why?

Dr. DORNBERGER. We are confronted with only a single competitor and that is Russia. Russia is able and has the money, the raw materials and the intelligence to conquer space. We learned from sputnik what it means under the present international political situation to achieve something in this field first. We have to do it or suffer the loss of our prestige among the free nations.

Mr. FELDMAN. Is that the only reason?

Dr. DORNBERGER. No, there are many reasons. The development of high-thrust rocket propulsion will give us the means and the tools to expand our field of travel tremendously in a vertical direction. Space travel promises tremendous new knowledge, the understanding and use of which we may not recognize now but in the next 10 or 15 years space will be an area of vast importance for our country both scientifically and militarily.

Mr. FELDMAN. I have no further questions.

Mr. MCDONOUGH. Mr. Chairman?

The CHAIRMAN. Mr. McDonough?

Mr. MCDONOUGH. In your early developments in Peenemunde did you use the research and experiments of Dr. Goddard to any extent?

Dr. DORNBERGER. No, we did not. Dr. Goddard was almost unknown to us. At least 98 percent of Dr. Goddard's patents were classified. We had no access to them. We had some information about Dr. Goddard's work by the American Rocket Society Journals, and that was all we got. But at that time, when we got knowledge, and we learned about Professor Goddard's achievements, we were already ahead and far ahead of him. The development in Germany was parallel to Dr. Goddard's and not one after the other.

Mr. McDONOUGH. But you worked on the same basis, the same basic principles?

Dr. DORNBERGER. Yes. I am convinced that any nation in the world, with the same scientific background and the same scientific and engineering capabilities and capacities, when tackling the same problems, would finally come out with the same solution.

Mr. McDONOUGH. Why, in your opinion, hasn't Russia shot another satellite up since the last one?

They have not shot another one since the last one. They have only put up two.

Dr. DORNBERGER. I am not quite sure that they didn't try.

Mr. McDONOUGH. You think they did try?

Dr. DORNBERGER. Yes.

Mr. McDONOUGH. You have no knowledge of that?

Dr. DORNBERGER. I have no knowledge of it.

The CHAIRMAN. How far ahead of us are the Soviets in the field of intercontinental ballistic missiles? Have you an opinion?

Dr. DORNBERGER. We got information that the Russians shot one ballistic missile over a range of 5,000 or 6,000 miles. I don't know of any ICBM we have fired over that range yet.

The CHAIRMAN. Thank you very much, Doctor. We appreciate your appearance. We are very glad to have you before us. I, as chairman of the committee, and on behalf of the other members of the committee, wish to express our thanks to you very much.

Dr. DORNBERGER. Thank you.

The CHAIRMAN. The next witness is the Honorable Donald A. Quarles, Deputy Secretary of Defense.

STATEMENT OF HON. DONALD A. QUARLES,[30] DEPUTY SECRETARY OF DEFENSE

The CHAIRMAN. We are very glad to have you with us, Mr. Secretary. Have you a prepared statement?

Mr. QUARLES. I have not, Mr. Chairman. I have come here with the thought of answering any questions you might have in response to your request about our comments on the legislation. I thought I would, however, not do that in a comprehensive way at this time, but merely consider with you any questions that the committee might have.

The CHAIRMAN. What is your opinion as between a director or an administrator, whichever you want to call it, and a commission form of agency?

Mr. QUARLES. Generally speaking, I think an agency with a single effective head is a preferable organization. Of course, that is not to say that the effective head of the agency might not have firm policy

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guidance by what would be the equivalent of a board of directors or a board of trustees or something of that kind.

But I think from the point of view of directing the agency, it would be more effective to have a single head rather than to have a commission as head of the agency.

The CHAIRMAN. You are confining your reply to this particular agency?

Mr. QUARLES. To this particular agency; yes, sir.

The CHAIRMAN. You do not want to go beyond that agency.

Mr. QUARLES. So that I will not be misunderstood, there are some commission forms of agencies which are extremely effective. But for this purpose, I would think a single director or a single head of the agency would be sufficient.

The CHAIRMAN. Do you think he should be on a high level?

Mr. QUARLES. I would think so; yes.

The CHAIRMAN. On the level of the National Security Council, for example?

Mr. QUARLES. Not necessarily on that level.

The CHAIRMAN. You would not exclude it, would you?

Mr. QUARLES. I would not exclude it, but I think that the level that we are talking about is not necessarily a National Security Council membership.

The CHAIRMAN. Do you think the Administrator should be a member of the National Security Council?

Mr. QUARLES. I would not see a reason for that; no, sir.

The CHAIRMAN. I will ask some questions later. I will ask the members of the committee if they have any questions.

Before doing that, however, you remember the Riehlman subcommittee, do you not?

Mr. QUARLES. Yes, sir; I do.

The CHAIRMAN. Has that had any effect? I thought we did a pretty good job. I sat in on all those hearings.

Mr. QUARLES. I thought the committee did an excellent job, Mr. McCormack, of delving into that problem. I would say it has had an effect. Like many of these things, one has to look carefully to see just what changes have taken place over a period of time. But I believe there very definitely has been an evolution, and in the direction your subcommittee was seeking. I hope you will agree with me.

The CHAIRMAN. Since sputnik I have seen some evidence.

Mr. O'Brien.

Mr. O'BRIEN. Mr. Secretary, you say you do not believe necessarily the Director of this new Agency should be a member of the National Security Council. May I ask why not?

Mr. QUARLES. Well, I think, of course, that the President might see fit to call on him for advice when matters pertinent to his work were involved. But the great bulk of the National Security Council matters would not be of interest to him, and I would say it would be better to have him called in as the occasional adviser rather than having him sit as a regular member, in my understanding of the character of his work.

Mr. O'BRIEN. Do you believe, Mr. Secretary, from your reading of the President's proposal and the several other proposals, that enough authority is granted the Director of this new Agency to do the job which should be done, or do you think that in writing or rewriting this

legislation, we should spell out more authority than presently provided?

Mr. QUARLES. My feeling was that the legislation as it stands does establish very substantial authority in this Director.

I am not sure that I have analyzed that as closely as one should. But certainly my impression is that the authority as it stands is appropriate and adequate for his purpose.

In the final analysis, of course, his authority is really his appropriation, and this is something that the legislation is, of course, silent on, other than authorizing the appropriation.

I would say that given the appropriations to do the job expected, that he has the authority to carry out the job.

Mr. O'BRIEN. Thank you. That is all, Mr. Chairman.

The CHAIRMAN. I think it is a good basis for consideration. I agree with you, Mr. Secretary. Otherwise, when introducing it, I would have stated "by request," but I did not do that. But as a basis of consideration, I think it was a job well done.

Mr. Metcalf.

Mr. METCALF. I have no questions.

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. Mr. Secretary, the bill before the committee providing for the Space Board provides that the Board shall not exceed 17 members and at least 1 of the members shall be from the Department of Defense. You are acquainted with that provision?

Mr. QUARLES. Yes; I am, Mr. Natcher.

Mr. NATCHER. Mr. Secretary, in your opinion, should each branch of the service be represented on this Board? Should there be more than one member from the Department of Defense?

Mr. QUARLES. As a general proposition, I would say that of the 17 members it would be appropriate not only to have 1 from Defense, but to have 1 from probably each of the 3 military departments, certainly 1 or 2 additional members from the Defense Department. I believe it is provided that not more than 8, is it not, shall be from Government offices and, of course, this would permit the possibility of 2 or 3 being from the Defense Establishment. Whether it would be wise and appropriate to specify that more than one be from the Defense Establishment I think is debatable. As a matter of fact, I am quite satisfied with the present provisions of the bill in that respect, assuming that appropriate people would be appointed when the time came.

Mr. NATCHER. Thank you, Mr. Secretary.

The CHAIRMAN. As a matter of fact, instead of spelling it out in the bill, you would prefer that at least one should be appointed from the Defense Department? That would allow more and that then would rest with the President in conjunction with the Secretary of Defense and the head of this Agency.

Mr. QUARLES. I think I remember now it does say at least one.

The CHAIRMAN. At least one?

Mr. QUARLES. Yes.

The CHAIRMAN. And then if we put one from each department, in miniature we are repeating the reorganization fight, are we not?

Mr. QUARLES. I think, perhaps, if you required that there be one from each department in legislation you might be stepping on organization's toes there, but I have not thought of it in that sense.

The CHAIRMAN. I said in miniature.

Mr. QUARLES. Yes; anyway, I would like to leave it that the present provision of the draft bill in that respect seems appropriate to me.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. Mr. Secretary, how do you visualize or anticipate the relationship between ARPA and the new Agency would be carried on? Do you propose, as I understand, that ARPA will continue to operate as part of the Department of Defense? Is that correct?

Mr. QUARLES. That is correct, Mr. Sisk, and we believe that there will always be advanced research projects in this particular space area, as well as perhaps in other areas.

There will be projects appropriate for military control and conduct, and these projects we would expect to continue to be carried on in the Advanced Research Projects Agency of Defense.

Just where that line will be drawn, and how the collaboration between Defense and the new NASA will be worked out, I think is the key question before us at this time.

Mr. SISK. That leads to my next question: Assuming that there arose a controversy as to a given project, or a given attempt to explore space, as to whether it has military significance or it should be exclusively under a military agency, who, in your opinion, should make the final decision? Should this Agency we propose to set up have authority vested in a Director to overrule ARPA, for example, and make that decision?

Mr. QUARLES. I would think that would not be appropriate, Mr. Sisk. I would think in final analysis that decision should be vested in the President and that the legislation should not attempt to draw the line too firmly and definitely because I believe administrative latitude will be valuable here in working out this relationship.

For example, I can well imagine that the line that one would draw initially when the new Agency is getting into this field might be somewhat different than the line one would draw after they had been in the work for several years and had become established in it.

In any event, I, myself, would like very much to see a continuation of the relationship—essentially the relationship—that has existed in the past in the aeronautics field between the Department of Defense and its military services and the National Advisory Committee for Aeronautics.

I do not mean to imply, by that, that in the space field the new NASA should not go farther and have its own projects—I think it should—but I think the main point here is to establish a collaboration between the two agencies, each drawing on the capabilities of the other, and each relying in confidence on the other in the way we have had it in the relationship between the Defense Department and its agencies, on the one hand, and the Advisory Committee for Aeronautics, on the other.

Mr. SISK I am inclined to agree with you; that is an idealistic setup. However, as a realistic setup, if there is an urgency, which we are told exists and which many of us believe exists, as controversies and disagreements arise, I understand you do say the President shall make the decision.

Now, I would assume you propose he would rely on Dr. Killian or his other scientific advisers. I am wondering if there would not be

rather lengthy delays because of the necessity of this third party, whether it be the scientific adviser to the President or another, making the decision. Apparently, you do not have that fear. Is that correct?

Mr. QUARLES. I do not have that fear, Mr. Sisk, for this reason: That I think, initially, there will be a determination by the President and, of course, when I say the President, I mean on his behalf and by him if he needs to make the determination, personally.

I think there will be a determination as between the defense agencies, let us say ARPA, and NASA, and that will establish a dividing line between them.

In line with that determination, they will each proceed on that program or on joint programs, as may be determined, and as new programs come along they will either fall into that pattern or, I think, can be promptly resolved.

I do not see that this would be a delay. In fact, on the contrary, it is the only orderly way you could carry on, and you might very well encounter delays if you did not have some orderly process like that for resolving the basic questions.

Mr. SISK. Do you think that should be spelled out in this legislation, then as to who might be called upon to settle these differences of opinion?

Mr. QUARLES. I think it is implicit in the legislation as it stands. It seems to me that it is quite clear that both the Defense Department and the new Agency are responsive to the President and, therefore, as in the case of all other executive-branch agencies, they would look to him for adjudication of any differences between them.

Mr. SISK. I believe that is all. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Mr. Secretary, do you think our immediate emphasis on space exploration should be for military purposes, or for peacetime purposes for civilian benefits?

Mr. QUARLES. I would like to say I think it should be both. I think one could not say it should be civilian to the exclusion of the military, because I think the national interest requires priority attention to the military and defense aspects of this program.

On the other hand, if one concentrated exclusively on these near-term military aspects and did not move vigorously into the longer range exploratory field to develop the science of this situation, then we might be grossly shortsighted and find ourselves outclassed as we get down the road further. I think it has to be both things, and both things in parallel, and both things with priority.

Mr. McDONOUGH. Under the many pertinent provisions in the bill before us is item 5 on page 2, which states:

> The making available to agencies directly concerned with national defense of discoveries that have military value or significance.

The National Space Agency that the bill would create, with at least 1 from the Defense Department in a board of 17, would, naturally, emphasize by its personnel and the limited number from the Defense Department more civilian investigation than the military. The bill, itself, states that the things discovered having a military purpose should be referred to the Defense Department.

The bill also provides that we should seek to cooperate with foreign nations and even enter into international agreements to bring about

peaceful settlement of how space should be used. What is your opinion about that?

Mr. QUARLES. I should not think it would be a function of this Agency to enter into international arrangements about the use of space.

Mr. McDONOUGH. I am wrong; I mean cooperate.

Mr. QUARLES. Yes, sir. Well, I would say that, with proper guidance as to the areas in which such cooperation should take place, it would be desirable and serve the national interest for this Agency to cooperate with other national bodies, or in international bodies, but that would have to be carefully considered in relation to those things that should be secured in the national interest.

I think it undoubtedly would be, but there certainly would be areas of general science in which it would be appropriate for this Agency to cooperate with the agencies of other nations just as we have in the International Geophysical Year.

Mr. McDONOUGH. Now, we are engaged in an International Geophysical Year at the present time. The purpose, of course, is cooperation and coordination between various nations on scientific exploration of space.

Suppose the International Geophysical Year terminates, and Russia then indicates that any attempt to use satellites for reconnaissance, surveillance, or investigation of outer space is an overt act. What position does that put us in, as a nation, in our military defense?

Mr. QUARLES. It is a little hard to see how they could take that position after their own experiments in this field, in which they seem to assume that there was no such question of international relationships.

Mr. McDONOUGH. Well, that was during the Geophysical Year. They did not shoot a satellite before. Neither did we. They did it during the Geophysical Year.

Mr. QUARLES. That is very true, but I think, from the point of view of international law and the rights of other nations, these were not changed by the International Geophysical Year, and anything that is proper to do in that year would be proper to do in the following year, from the point of view of rights of nations.

We ceded them no rights, and they ceded us none, although our scientists did enter into cooperation in this Geophysical Year program.

My only point is that I would not expect that they could take the position that an orbiting satellite would be an infringement on their national rights, but, if they do so, that would, of course, have to be a matter for our State Department to deal with and not for this Agency to deal with.

Mr. McDONOUGH. Suppose they release a satellite that we know is capable of reconnoitering the United States, and we have no such satellite in orbit. Would that be considered an invasion of our security?

Mr. QUARLES. I am not enough of a lawyer, Mr. McDonough, to answer that question. I can only express the Defense Department's view of it, that, if they did place in orbit a satellite that had such reconnaissance possibilities, we would consider that it was inoffensive in the sense that it was in outer space where it could do us no harm and we could not object to it.

Mr. McDonough. Of course, we do not know whether Sputnik II had such capabilities, because we could not decode the messages from it, could we?

Mr. Quarles. I think it is true that we do not know, definitely, what information either sputnik actually obtained and returned. There were intimations that information of that kind might be gathered. Whether such information was or was not gathered, I think, we do not know.

Mr. McDonough. Were they able to decode the messages from our satellites?

Mr. Quarles. The information gathered and returned by our satellites was in accordance with the international agreements and codes and freely available to all nations participating.

Mr. McDonough. That is all, Mr. Chairman.

The Chairman. Mr. Fulton.

Mr. Fulton. I yield to Mr. Keating at the present time, Mr. Chairman.

Mr. Keating. Mr. Secretary, this bill says that not more than one shall be from the Defense Department. There have been some recommendations here that we incorporate language saying not more than one each from the Army, Navy, or Air Force.

Would you be opposed to language of that kind?

Mr. Quarles. I would not oppose it, Mr. Keating, but I do not think I would advocate it on the theory that if the representatives of Army, Navy, and Air Force appeared to be the best-qualified members for appointment to this 17-man Board, we would certainly recommend their appointment, and I have every reason to believe that the recommendations would be given sympathetic consideration.

So I do not see the necessity for incorporating such language into the act.

Mr. Keating. Would not language of that kind be contrary to the spirit of the Defense Reorganization Act which has just been presented to Congress?

Mr. Quarles. One could say that it is and for that reason there might be some advantage in omitting it.

Mr. Keating. In other words, if there were to be 4 from the Defense Establishment, not more than 4, or not more than 3, or any other number, do you not feel they should be designated by the Secretary of Defense?

Mr. Quarles. I think that would be a good approach to the matter at this time; yes, sir.

Mr. Keating. There has been discussion here about spelling out the method by which liaison shall be maintained between the armed services and a civilian agency. Do you favor simply setting up the liaison requirement in general, or spelling out the details in legislation?

Mr. Quarles. I favor legislation which establishes the agency and defines its purposes and functions broadly and does not attempt too rigidly to establish a line between this Agency and the military agencies, for two reasons:

I think that this will be an evolving relationship as time goes on. I think that initially there might be one division between them and as the new Agency builds up there might very well be a somewhat different relationship.

Generally speaking, I think it would serve the national welfare best to have the flexibility which would enable the two agencies under the direction of the President to adjust this dividing line between them as time goes on and according to circumstances.

Mr. KEATING. Do you not think that if we were going to set up definite guidelines as to how that liaison should be accomplished, we could do it better after the Agency had been in operation for 2 years than at this time?

Mr. QUARLES. I think that is true; yes, sir. I would like to recommend that the legislation not attempt to establish prohibitions that, let us say, Defense shall not do certain kinds of things and that the Agency shall not do certain kinds of things.

I do not believe that is necessary. Both agencies should be working for the national welfare in their respective fields and there should be a possibility of adjustment between them under the direction of the President, I should say.

Mr. KEATING. Now, you gave an answer to Mr. McDonough on one question that rather surprised me, if I understood you correctly. He asked you about the Russians sending satellites with reconnaissance capabilities over this country.

I understood you to say that no harm could come from it, so we could not object.

Now, my understanding is that from 500 miles up you can take a picture of an object, or you can see an object 2 feet long on the earth.

Will you set me straight on it?

Mr. QUARLES. On the point that we could not object, I meant to speak here as a military man rather than as an international lawyer. I would not like to say that the State Department would feel they could not object. I do not know whether they would feel they could object, or not.

I know in a military sense it seems to me that objects orbiting in outer space have an international character by the very nature of their position there and that it would be inappropriate for us to take the position that what you could see from there of our area would be improper for them to see any more than it would be improper for a reconnaissance group stationed on the moon to use a spyglass to look at us.

I just think we cannot establish that kind of position that these are improper or objectionable or offensive.

So I would have the view that we would not seek to object to such reconnaissance.

Mr. KEATING. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Ford.

Mr. FORD. Mr. Secretary, in the declaration of policy on page 2, there is this sentence:

> The Congress further declares that such activity should be directed by a civilian agency exercising control over aeronautical space research sponsored by the United States except insofar as such activities may be peculiar to, or primarily associated with, weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense.

In your opinion, does that declaration of policy in any way run contrary to or inhibit what you feel is the rightful area of the Department of Defense?

Mr. QUARLES. Again, not speaking as a lawyer, but in my own appraisal of the position, I would say that if the legislative history makes it clear that there is no intent in this phrase to imply a prohibition, then it would be all right because it can certainly be interpreted to give the latitude that I would think appropriate, the latitude of judgment as between Defense and the civilian agency.

However, if the legislative history tended to make you construe that phrase narrowly as a kind of prohibition against defense, I would find it not in the national interest, for this reason:

The Defense Department, it seems to me, must have the latitude to pursue those things that are clearly associated with defense objective as stated here. It must also have the latitude to pursue things that are potentially important to defense and to pursue those within the Defense Department or in cooperation with, for example, the civilian agency, if it is covering the subject matter.

I would think that a narrow construction which could be cited against Defense if they get just a little bit over the line here, would be not in the national security interest, and, therefore, not in the national interest, and I would recommend against such a narrow construction.

But I do not believe these words necessarily must be so narrowly construed

Mr. FORD. It would appear to me from a reading of that language that the Department of Defense is given more or less the authority to make such a decision. That is certainly the way I feel it should be construed. Any other construction would be a very narrow prohibitive construction, so far as words are concerned.

Mr. QUARLES. This is why, Mr. Ford, I hedged a little bit on your question because I am not quite sure how it would be construed in the absence of statements such as the one you have just made in the legislative record back of this legislation.

I think it is important to recognize that the agencies have been, or are being established by the Congress, to serve the national interest in their respective spheres and what the Congress and the people are looking for is the maximum national interest.

And too rigid a line between them would not in my opinion serve the maximum national interest.

Mr. FORD. It seems to me from the testimony we have had and the comments I have heard from the various members of the committee when we discussed this language, that there is no disposition on the part of this committee to restrict that language so that the Department of Defense is inhibited in any way whatsoever.

As a matter of fact, it is my recollection most of the members have expressed a desire that that language be crystal clear in this regard so as to give the Department of Defense certain latitude necessary to its operation.

Mr. QUARLES. Mr. Ford, I wonder if I might pursue that point a little bit further.

The CHAIRMAN. You will have the opportunity of reviewing your remarks, Mr. Secretary, when you edit them and you can elaborate or add thereto and we hope you will.

We realize when you are asked questions and you answer extemporaneously that it is a different proposition than if you were putting down in writing your reflective and mature thoughts.

Mr. QUARLES. I would only like to bring out, if I may at this time, the point that the President in Executive Order 10521 establishing basic research functions—and this, Mr. Chairman, you, yourself, are very familiar with—made it a function of the National Science Foundation to be the central point for the support of basic research in the Federal Government, but charged each one of the executive departments with such support of basic research as would be appropriate in the fields of basic research underlying their particular activities.

I think one should have this same general philosophy in approaching this matter as well as basic research more broadly.

Mr. FORD. Mr. Secretary, you have had a great deal of experience with research and development in the military and with funding problems. I presume you would concur in the language in section 9 (a) which gives this Agency no-year fund authority in contrast to 1-year fund authority.

Mr. QUARLES. I would very definitely, yes, Mr. Ford.

Mr. FORD. Would it be detrimental to the progress of the agency if it had only 1-year fund authority?

Mr. QUARLES. I would feel that it would either be detrimental to the agency, or would not make the best use of the appropriated funds.

Mr. FORD. Thank you very much.

The CHAIRMAN. Mr. Secretary, I am going to give you some questions in writing which I would like you to think over. It relates to the declaration of policy, page 2, point 6:

> Cooperation by the United States with other nations and groups of nations in work done pursuant to this act and in the peaceful application of the results thereof.

Further on, section 6, paragraph 4, on the functions of the agency, the bill states that the Agency shall:

> Arrange for participation by the scientific community in planning scientific measurements and observations—

and so forth.

One of the questions is: Should the power to cooperate with individuals or groups abroad be authorized?

You see, it is on a nation-to-nation level.

Furthermore, what is your definition of a "scientific community"? That is very important. How would you define "scientific community"?

Is it the scientific community of the United States, or whatever relationships might be entered into abroad? Would the new Director of the Space Agency disseminate an underlying policy of the department and the AEC?

In other words, foreign policy might be involved. That should be given consideration in connection with the drafting and reporting of the bill.

What arrangements will the new Space Agency make with other Government bodies in implementing cooperation with other nations in the dissemination of data? What would be its official relationship with the Soviet Union?

In answering these questions, will you also send me a letter so that I will have it directly?

Mr. QUARLES. Of course I shall be glad to, Mr. Chairman.

The CHAIRMAN. I wish you would look over the bill and see if you have any suggestions to offer as to why it should be changed or strengthened. We would welcome that very much.

Now, some of these questions that Mr. Ford asked you regarding page 2:

Except insofar as such activities may be peculiar to, or primarily associated with, military weapons systems or military operations—

we start out by establishing a civilian agency and say: "except," in which case they must be confined to activities which may be peculiar to, or primarily associated with, military systems.

Who is to judge? Suppose there is an honest difference of opinion, to whom would they go to make the decision?

Mr. QUARLES. Mr. Chairman, we have been working with this same general line of division with the National Advisory Committee for Aeronautics. I do not say that a legal definition has been the same, but the concept has been the same.

This has been going on for many years. To the best of my knowledge there has never been a need for referring a dispute to any higher authority, we have always agreed.

The CHAIRMAN. Of course, research and development has not been so intense as it is now. Because it was not so intense, the complicated questions did not arise.

Mr. QUARLES. Perhaps we are moving into a more difficult period and with more likelihood of a dissent arising. I only mean to point out that I think it is not too likely that we will be unable to reach agreements among ourselves about these matters as between the two agencies, but in the event that we cannot, it seems to me to be clearly a matter for Presidential determination; Again, of course, using his advisers to assist in that determination.

The CHAIRMAN. Of course, the President cannot pass on every question, but it would be the President or somebody designated by him. I assume that is what you have in mind?

Mr. QUARLES. In the last resort the President is always there to make the determination. It would be very poor administration if we referred each one literally to him, of course.

The CHAIRMAN. I am a great believer, under our constitutional setup, in preserving the rights of the President. We have over here provisions for reorganization in the next 3 years. Suppose the agency wants something to come under the NASA that is part of the Science Foundation or part of ARPA? Then it has to be approved by the Defense Department and the Science Foundation, there is a veto power there, and then it is subject to approval by the President.

Do you not think the President should be the top man? That should be a matter of phraseology. We can take care of that matter very easily, but I would like your opinion for the record.

Mr. QUARLES. I think he should be, and I must say I read the legislation as making him such.

The CHAIRMAN. It is a hard thing to draft. It is easy to examine a draft and pick out any weakness.

Mr. Fulton?

Mr. FULTON. I have several short questions.

Should we on this committee not see that ARPA has the right to do extensive basic research, as distinguished from weaponry programs?

Mr. QUARLES. I would say that we should not exclude ARPA from basic research, Mr. Fulton; that is right.

Mr. FULTON. Would you then for the record, rather than doing it now, give us the form of language which would make sure in legislation that ARPA would have the right to continue basic research which might eventually lead to weaponry?

The CHAIRMAN. Does not ARPA have the authority to make basic research?

Mr. QUARLES. I would say that it now does, but of course, it is conceivable that in this field of aeronautics and space research one might construe this legislation as excluding ARPA from it. I shall be very glad, however, to give you a suggestion along that line.

The CHAIRMAN. I am sure there is nobody in this committee who would think of that because we recognize the practical situation in the world today.

We must have our civilian agency and I am for it, but we must recognize the importance in the world today of a strong Military Establishment, up to date in all ways.

Mr. QUARLES. I think the important thing here is to see in NASA a research and exploratory development agency which would probably carry the great bulk of the load, of the research load in this field, and carry it equally for ARPA and for civilian agencies, but I would not think it wise, and I do not believe they would think it wise, to have any exclusion of ARPA from supporting research if that seemed to be appropriate, understanding that it would be coordinated with the program of NASA.

The CHAIRMAN. I do not think Mr. Fulton's question was on any theory of exclusion.

Mr. FULTON. You see, your point, Mr. Chairman, of the word "except" on page 2, line 7, brings into complete focus whether there is an exclusion of one from the other because when we read further:

except insofar as activities may be peculiar to, or primarily associated with, weapons systems or military operations—

it might exclude ARPA from basic research that has no immediate military application.

So that following on the chairman's point, if you could submit us language along that line, it would be appreciated.

The CHAIRMAN. I had not thought of that, but certainly there is nobody on this committee who is even remotely thinking of that. Will you give us some language on that?

Mr. QUARLES. I shall be glad to study that and report to you, Mr. Chairman.

Mr. FULTON. Of course, on advancing the national space policy, we should not in any way supersede or remove the present strategic security resources of the United States that are in the military forces, should we?

Mr. QUARLES. I certainly feel we should not, and in fact, great care should be exercised not to lose any momentum in the transition.

Mr. FULTON. And we, therefore, should have other programs developed rather than cut out programs that are now underway in ARPA and other agencies, if we can.

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Mr. QUARLES. Well, I think some of the programs we have started in Defense, we would consider quite appropriate for the other agencies to take over when they are ready to do so.

Mr. FULTON. That is right. We should not by this program start relying on space agency equipment and give up something that is now defending us basically.

Mr. QUARLES. I agree completely.

Mr. FULTON. For the immediate future, 3 to 5 years, the Strategic Air Command and its B–52's are just as necessary as we think the missiles might be.

Mr. QUARLES. They certainly are and I see nothing in that time period that could relieve the B–52 of its burden.

Mr. FULTON. You would not suggest that we change over to AEC directorship at this time, would you?

Mr. QUARLES. No, I would not make that suggestion. I perhaps was not too careful in phrasing my response.

When I spoke of the directorship I was speaking directly to this Agency.

Mr. FULTON. On a national space policy should that be established overall by a civilian agency, for everybody, including the military, with, of course, the right of operations in the military and the military planning to be done by the Department of Defense, its various organizations and services?

Mr. QUARLES. I would say not. I would say that the President as the Commander in Chief working with the Secretary of Defense, must preserve that line for the establishment of defense policy and there should be no other agency that in any sense could intervene in that line of policy determination of defense matters.

Mr. FULTON. A previous witness suggested that the exchange of information, through the translation of books, magazines and periodicals, should be under the United States Information Agency. I would question that because that happens to be a United States instrument of policy in foreign affairs and might have a relationship to a cold or economic war or a propaganda purpose.

Would it be possible for an outside agency to take over these functions, possibly part of the Space Agency? The Library of Congress could handle it.

Mr. QUARLES. As you know, Mr. Fulton, there is in the Library of Congress an agency of that kind. There is also such an agency in the Department of Commerce.

Mr. FULTON. We have Dr. Sheldon on our staff from the Library of Congress. I mean broadening the scope to take over the overall gamut of a national space program.

Mr. QUARLES. I would suggest that insofar as you are dealing with basic science and publishable scientific information, it would be well to either vest that in the new Agency or let the new Agency work with such an organization as the one already established in Commerce to carry on this interchange.

However, in respect to material that includes national secrets that should be secured under our National Secrets Act, whether they be restricted data or military secrets.

I think that the agencies presently responsible for security of that information and for the interchange of such information with for-

eign countries should remain responsible for it and that that should not be delegated to a new agency.

Mr. FULTON. I congratulate the United States Air Force on the publication in March 1958 of its glossary of scientific terms in the astronautics field. I think it is a good thing.

Mr. KEATING. Mr. Chairman, could I ask just one question?

Mr. NATCHER (presiding). Mr. Keating.

Mr. KEATING. We do have a program, do we not, for the development of an antisatellite missile or what we might call an antimissile missile?

Mr. QUARLES. We have a program for the development of an antimissile missile that I suppose could be construed as potentially a program for the development of an antisatellite missile, but that would be stretching the project pretty far, Mr. Keating.

I think it would be better to regard it as a project for an antiballistic missile system or missile.

Mr. KEATING. In other words, it is directed against a weapon and not against a satellite. Is that it?

Mr. QUARLES. That is right, and the distinction really is that the weapon is reentering the atmosphere and getting within range of a target that it may be attacking and the problem of destroying a weapon that is reentering the atmosphere is quite a different problem from that of destroying a satellite that might be several hundred miles away from the surface of the earth at all times.

Mr. KEATING. And it is not directed under our present program against satellites which might be flying several hundred miles up in the air over the country?

Mr. QUARLES. Our project as presently organized is not so directed, although there are people connected with the project who are thinking about the larger problem.

Mr. KEATING. That is all, Mr. Chairman.

Mr. NATCHER. Mr. Sisk, I believe you have one additional question?

Mr. SISK. Thank you, Mr. Chairman.

Mr. Secretary, I am asking these questions in the light of testimony just ahead of yours by Dr. Dornberger. The question is this:

If the Department of Defense has had the Dynasoar project since 1951, available for development, why is it that it just now is getting ready to move on that? Can you make any comment on that at all?

Mr. QUARLES. I can, Mr. Sisk, in this sense: The Department of Defense, in this case the Air Force was the responsible agency, has, of course, a great multitude of proposals that are made to them that are being evaluated by the Department as to either immediate value or long-range exploratory value. While, of course, the judgment in evaluating these things is not infallible, it is still the best judgment we can bring to bear on it. I can only say that this project was not authorized and prosecuted simply because it was not given values to justify such prosecution.

Mr. SISK. In view of recent actions on project Dynasoar by your Department, do you expect contract awards to be announced soon?

Mr. QUARLES. The project is with the Air Force and an Air Force recommendation has not come to Defense on it. So I would be getting ahead of myself to predict what the Air Force will do.

I believe I know that they are interested in certain preliminary work on this project, so I would not be surprised at a recommendation

that we pursue it, to limit it to objectives, but I have not received that recommendation yet, Mr. Sisk, so I really am not in a position to respond definitely.

Mr. SISK. Thank you, Mr. Chairman.

Mr. NATCHER. Mr. Feldman.

Mr. FELDMAN. Mr. Quarles, in response to a previous question, you said it was important to establish a continuous collaboration between the agencies. I assume you meant between the military and the new NASA setup?

Mr. QUARLES. That is right, Mr. Feldman.

Mr. FELDMAN. What is your understanding of liaison, the function of liaison?

Mr. QUARLES. Well, just abstractly, do you mean now, without any particular reference to this situation?

Mr. FELDMAN. Without any reference to this situation, yes.

Mr. QUARLES. My understanding is that when we have 2 organizations which have extensive dealings with each other, or important relationships between them, that it may very well be justifiable to set up a liaison agency which would be 1 or more persons charged specifically with moving back and forth between the 2 organizations to make sure that each to a maximum degree is informed of the operations and activities of the other.

Mr. FELDMAN. In other words, there is a flow of information between both organizations in order to prevent unnecessary duplication, so that the right hand knows what the left hand is doing?

Mr. QUARLES. I would say that is the fundamental and primary purpose of a liaison agency, yes.

Mr. FELDMAN. In order for liaison to be effective, it should be continuous. Is that not so?

Mr. QUARLES. Yes, I would say that is so, but I believe you are leading me into an implication there that I do not quite agree with, so I had better be more explicit.

In order for liaison to be effective it must be as continuous as the circumstances require.

Now, I can imagine organizations which would have such infrequent liaison that you would not justify setting up of a particular group charged with that purpose.

If you will allow me to define continuous as meaning there should be no interruption of it, then I agree.

Mr. FELDMAN. You have language in statutes which contain the exception that was read to you before, namely—

except insofar as such activities that may be peculiar to, or primarily associated with, weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense.

I continued to read from the memorandum for the Secretary of Defense and the Chairman of the National Advisory Committee for Aeronautics, dated April 2, 1958—I am now reading from the next to the last sentence in the third paragraph:

However, it is appropriate that a civilian agency of the Government take the lead in these activities related to space, which extend beyond the responsibilities customarily considered to be those of the military organization.

Now, those are terms and we know, of course, in this situation there is a good deal of overlapping and also a good deal of cointerest in many of the projects.

In other words, the military is as interested in weather as a nonmilitary agency. The military is as interested in communications as is a nonmilitary agency.

So a myriad of problems will arise and they will need direct scrutiny.

Mr. QUARLES. I think we would need direct scrutiny, yes.

Mr. FELDMAN. Are you acquainted with the liaison that exists between the military and the AEC?

Mr. QUARLES. I am well acquainted with it, Mr. Feldman.

Mr. FELDMAN. Has it functioned well?

Mr. QUARLES. I would say it has functioned well.

Mr. FELDMAN. Is it continuous?

Mr. QUARLES. Yes, because the military liaison committee is in continuous session.

Mr. FELDMAN. Would you object to the inclusion in this legislation of a provision similar to the one contained in the Atomic Energy Act of 1954, which is pretty broad in scope?

Mr. QUARLES. I would say in my best knowledge it is not needed as a portion of the act and that the act would be better legislation without it, in my opinion, for this reason, Mr. Feldman: Liaison is best accomplished where it is possible for the heads of the agencies themselves to have direct dealings and understandings with each other. Any time they have to set up an intermediary they are compromising. They are recognizing that they do not have time themselves to deal with each other.

Now at least initially, I believe that General Doolittle and Dr. Dryden, who are now on the NACA side, and Mr. Johnson and Dr. York here, who are now on the ARPA side, can to much better advantage establish their direct liaison relationships rather than having a statutory intermediary between them.

So I would recommend against the establishment of a statutory liaison agency between Defense and this organization. I do not say that we could not make it work, but I go along with the theory that in Government it is better to have as few agencies as possible and this is one I do not now see a need for.

Mr. FELDMAN. This would necessarily be a separate agency, but if a great number of these problems arise, that would be rather time consuming; is that not so? I know that in business the head of a large company would not undertake to do the labor-relations work of that organization.

I know from my own experience that whenever an attempt was made to have the head of a large company engage in labor relations it meant that for all times in the future he had to be the labor-relations representative for the company. It would be so time consuming that he would never have any time to do anything else.

Now, the same thing could arise here and the result, of course, would be that his time would be consumed along those lines. You do not see, for example, George Meany, who is the head of the AFL–CIO, or Mr. Reuther engaging in personal negotiations with labor-relations representatives of companies. They stay in the background. They let somebody else down the line iron out the details and then come to them with the big problems. I am just speaking now from the organizational point of view. I am not wedded to the idea, but I am trying to evolve something that will be effective.

That leads me to this question. Under the new proposed Agency setup the Board is to meet no more than four times a year. The Board must contain one military member. On that basis I think General Doolittle stated that liaison would be automatic.

Now, assuming that the Board met 10 times a year, do you think that that single member of the Board from the military or 3 members from the military meeting 10 times a year would be able to make that liaison automatic?

Mr. QUARLES. No; I do not think that liaison through the Board would be a proper concept, I agree, and a Board member would not in my concept be an appropriate liaison of the kind you are speaking of. Might I carry that point a little farther and say that I am sure that the heads of the agencies found they did not have time or as the relationships got more intricate and time consuming they could establish working relations between them without the need for any legislative instructions or definitions as to just how they should do so.

That would be my only point on the matter, Mr. Feldman.

Mr. FELDMAN. Well, then, we will have the heads of the different agencies occupied with continuous meetings. What harm would there be, then, in having that provision in the law?

Mr. QUARLES. I did not mean to say that I envisaged a specific liaison organization between the agencies. I do envisage a liaison arrangement between the agencies. I think to define it in the statue would be undesirable because you might very well want to start out with some very simple arrangement that did not involve a separate organization and you might later want to evolve toward the delegation of the function to some subordinate official of each organization.

I just think it would be better not to define it in the law. I do not see a statutory purpose that such liaison committee would serve.

The CHAIRMAN. Is it not almost certain, because of the general language I read to you before, that you will have to have some liaison setup?

Mr. QUARLES. I think you will have to have some liaison, but when you say set up you imply to me a specific organization solely for that purpose and that I would say I do not see the need for.

Mr. FELDMAN. Would you revise the Atomic Energy Act and not have the Statutory Liaison Committee?

Mr. QUARLES. From where we are today and knowing what has been involved in revising the Atomic Energy Act, I would not recommend such a thing. But I do not feel that you are dealing with an analogous situation here. There were certain principles in the original act primarily related to a sense of special security and special national interest in the security of atomic secrets that led to that whole organization and I do not think you have a parallel situation here, and I therefore would not like to argue by analogy that we should have a military liaison committee here because we had one there.

Mr. FELDMAN. I do not think that is the only reason that led to the establishment of that committee in law itself. I think one of the requirements was because the military had a pretty big stake in the program and they wanted to continue that stake. My own thought is that it might be better served by having such a liaison committee established in the law itself.

However, as I say, I am not wedded to the proposition and I am in the nature of a devil's advocate trying to find out.

Mr. QUARLES. Mr. Feldman, I have given you my best judgment on it.

Mr. FELDMAN. The President's bill provides, and I am referring again to section 2, for exclusive civilian control—

except insofar as activities may be peculiar to, or primarily associated with, weapons systems and military operations.

Now, approximately what proportion of the activities of the outer space agency do you anticipate would come within that exception?

Let us put it this way: Would it be a substantial part or small part?

Mr. QUARLES. To be sure I understand your question, of course those things that came within the exception would not come within the outer space agency. So may I answer in this sense, that what fraction of the total national space program would fall within the civilian agency and what fraction would fall within the military under this definition—may I answer it that way, Mr. Feldman?

Mr. FELDMAN. That is right.

Mr. QUARLES. Initially I would expect that the majority of the program in this field, the majority dollarwise of the program, would be military. Perhaps as much as 75 percent would initially be military. I would expect the civilian percentage to build up proportionately over the years.

I do not think I can look down the road very far in this matter, but at any rate I would say that as far as I can see, one would expect a substantial fraction of the project work to be military project work in the sense of this proposed legislation.

Mr. FELDMAN. Assuming the language were changed to read: "Pertaining to weapons systems or military operations," would you answer me the same?

Mr. QUARLES. My answer would be the same because as I discussed with Mr. Ford earlier, I am construing and I hope we may construe these words broadly in defining the areas of the two agencies.

Mr. FELDMAN. Now, assume, for example, that the outer space agency would take over the Vanguard and the Redstone projects under its contract and lease authority on page 8, subsection 6 (5), or its transfer authority, page 15, section 8. Should it do so, in your opinion, or should those projects remain under military control?

Mr. QUARLES. On the Vanguard project the answer would be solely a matter of timing. I think the Vanguard project as we visualize it now will not be one that enough is left of to make it appropriate for this agency to take it over when the Agency is ready to go as an operating agency. I am not quite sure I know what project counsel refers to in the Redstone project.

Mr. FELDMAN. I mean the whole Redstone project.

Mr. QUARLES. The Redstone project in my definition, Mr. Feldman, is a Redstone missile project which is entirely military and entirely inappropriate for the Agency to take over, but I may misunderstand it.

Mr. FELDMAN. The language says, "On behalf of the Department of Defense."

Mr. QUARLES. Perhaps you have in mind that the new civilian agency might take over some part of the Army Ballistic Missile Agency at the Redstone Arsensal. If that is what is meant by Redstone, then

I think that they could do that as soon as they are ready and as soon as they have projects that would be appropriate for the Ballistic Missile Agency to undertake.

Mr. FELDMAN. Well, there is a possible construction of those words, "on behalf of the Department of Defense" which would enable the civilian agency to take over.

Mr. QUARLES. If I construed "on behalf of" as meaning that if by agreement it looked best for them to take it over, would this not be a fair construction?

Mr. FELDMAN. Not necessarily. If you have those words inserted in the statute itself, it would obviate the need for that kind of interpretation.

Mr. QUARLES. I thought if a man did something on my behalf it was because I wanted it. I did not know he just could do it.

Mr. FELDMAN. If you give him the authority to do it on your behalf, he can decide that for himself.

Mr. QUARLES. Sir, you know better than I.

Mr. FELDMAN. In your opinion, to take a further example, what agency should have charge of developing a million pound thrust rocket, the outer space agency, ARPA, or the AEC?

Mr. QUARLES. That project today is a joint project in which NACA carries certain aspects of it and the Air Force is the contracting agency for contracting work in that field.

I would find that to be the desirable organization of the project for the time being, but I do not at all exclude a more positive control of the project by NASA when and if that organization is operating. Really today they work so closely together it would be hard to say which organization is controlling it.

Mr. FELDMAN. The President's bill contains authority to operate as well as to develop and test aeronautical and space vehicles. I refer to page 6, lines 1 and 2, page 7, lines 7 and 8.

In your opinion, does the Outer Space Agency need such authority?

Mr. QUARLES. I feel, Mr. Feldman, that they do need the authority to operate. I think, however, the language should not imply an exclusive authority to operate. As I say, again, I think, it can be presently construed as not being exclusive and if we may so construe it, then I agree with the language.

Mr. FELDMAN. But if it does not, why you would think it should be changed in that respect?

Mr. QUARLES. I do not think it should be given exclusive authority to operate in this field.

Mr. FELDMAN. Does not the NACA have authority to operate aeronautical vehicles now?

Mr. QUARLES. It does have. I have not examined the law, but I know in fact it does operate such vehicles so I am quite sure it has the authority to do so. And I think it should have although most of these aeronautical vehicles are joint projects in which one of the military services actually operate the vehicle in a joint enterprise with NACA.

Mr. FELDMAN. The NACA Board at the present time is the executive group within the Agency. The director serves under the Board. The new proposal makes the director the top executive and the board's function is primarily advisory. Do you have any thoughts in that connection?

Mr. QUARLES. I am frank to say that I was surprised when I read this part of the legislation and wondered just what was meant by it. I believe that the intent here was to be sure that there would be vested in the director the authority to proceed expeditiously with the work.

Of course, with that we are all in sympathy. I think, also, there was the intent that the director should be responsive to the chief executive and that there should be no intermediary board that could intervene between the director and the chief executive.

Also, with this I am in thorough agreement. I do think that the present NACA arrangement has been a constructive one in which a governing committee has in effect set policy for the committee and its operations.

Mr. FELDMAN. I have heard it said that one of the reasons for the creation of this new agency was because of the success of the sputniks and the so-called public hysteria which resulted at that time, and that there was no need for any high level agency to operate in the space field except to calm that hysteria.

Do you agree with that conclusion, Mr. Quarles?

Mr. QUARLES. I cannot say there was no hysteria at the time of the sputniks, but I do not agree that this legislation was based on such hysteria. I think that there is a sound need for a civilian agency in this field. I would say there is, and quite aside from sputniks, I support a civilian agency for an appropriate part of this work.

Mr. FELDMAN. And it should be on a high level, is that not so?

Mr. QUARLES. I think the level on which it is cast by this legislation is appropriate, yes.

Mr. FELDMAN. Not higher than that?

Mr. QUARLES. I do not think it need be any higher level than it is. I said earlier that I did not see a need, for example, for permanent membership on the National Security Council of the head or the director of that Agency.

Mr. FELDMAN. The Atomic Energy Act contains rather detailed provisions, referring now to chapters 11, sections 121 through 125, for international agreements on cooperation and provisions for indemnification up to an aggregate amount of $500 million and limitation of liability. I am referring here to section 170.

In your opinion, should the President's bill be amended so as to include similar provisions? I am not talking about any $500 million limit on aggregate liability, but some such provision.

Mr. QUARLES. Mr. Feldman, I would say there is not here a reason for indemnification in such large amounts that there was in the Atomic Energy case. I think that the matter of indemnification should be covered either in this or in general legislation. As you perhaps know, we have a bill, now pending before the House Armed Services Committee on this broad point as far as defense is concerned.

Mr. FELDMAN. Would it cover this civilian agency?

Mr. QUARLES. I am not sure of that, but I will be glad to go back and make sure of that. There is no doubt that broad legislation on indemnification should cover such an agency as well as defense.

Now, on sections 123 and 125 of the Atomic Energy Act that deal with agreements for international cooperation, these sections are addressed almost entirely, as I recall, to the problem of maintaining the security of restricted data and at the same time allowing enough

latitude, what the Congress deemed to be proper latitude, in making agreement with other countries in the handling of restricted data.

I would not see a reason for paragraphs of that kind in this act because, as I think I said to Mr. Ford, it would seem proper to me that we leave the responsibility for handling of national secrets where it now is and not vested in this Agency.

In other words, if they are national secrets in the restricted data area the responsibility would remain in the Atomic Energy Commission.

If they are in the military area other than restricted data, it would be in the Defense Department, and in respect to interchange with foreign countries or foreign nations, the State Department, of course, becomes one of the agencies jointly responsible for it.

We have regulations now that set all of this forth. I would think it would be well to let the handling of these secrets remain where it now is and leave this Agency in a field of unclassified work rather than have classified work as far as international agreements are concerned.

Mr. FELDMAN. I have no further questions.

Mr. NATCHER (presiding). Mr. Secretary, on behalf of our chairman, Mr. McCormack, and the other members of the committee, I want to thank you for the fine statement you have made and for your appearance before our committee at this time.

The committee will adjourn until 10 o'clock in the morning.

Mr. QUARLES. Thank you, Mr. Chairman.

(In response to various requests for information Mr. Quarles submitted the following material:)

THE DEPUTY SECRETARY OF DEFENSE,
Washington, D. C., May 19, 1958.

Hon. JOHN W. MCCORMACK,
Chairman, Select Committee on Space and Astronautics,
House of Representatives.

DEAR MR. CHAIRMAN: This is in response to requests made during the course of my testimony before the Select Committee on Space and Astronautics for additional information.

The question was raised as to whether the Advanced Research Projects Agency would have the right, under the proposed legislation, to continue basic research. I stated at that time it was my opinion that the language of the bill would preserve the right of ARPA to undertake required basic research. I understand that during subsequent hearings on the bill Mr. Dechert, our General Counsel, and Mr. Roy Johnson, Director of ARPA, submitted language which would make clear that activities peculiar to or primarily associated with weapons systems or military operations will be the responsibility of the Department of Defense. This suggested amendment, read in conjunction with Executive Order 10521 would, in my opinion, remove any doubt that might have previously existed as to the authority of the Department of Defense to engage in required basic research.

The indemnification legislation to which I referred is H. R. 11639, now pending before the House Committee on Armed Services. This proposed legislation would not specifically cover contracts of the proposed new Space Agency except in those instances where the proposed Agency and the Department of Defense entered into a joint undertaking with the Department of Defense acting as the contracting agency.

I am attaching hereto as a separate statement responses to your specific questions with respect to international cooperation.

Sincerely yours,

DONALD A. QUARLES.

ANSWERS TO QUESTIONS POSED BY HOUSE SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION

1. In the declaration of policy, point (6) states that a policy objective is "cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof * * *"

Question. Should cooperation with individuals and groups abroad be authorized?

Question. How do you think the Director of the new Agency would implement point (6) in the declaration of policy? (The bill does not contain implementation of this policy on level of nations.)

Answer. The statement of policy objectives, including point (6), is interpreted as defining national objectives and not necessarily the functions of the new Agency. For example, it seems unlikely that cooperation with "other nations and groups of nations" would be carried out directly by NASA, except to the extent that the State Department had established channels for such cooperation. There would appear to be no need in the statement of policy to extend point (6) to include cooperation with individuals and groups in other nations, since this is implicit in cooperation "by the United States with other nations." The "work done pursuant to this Act and in the peaceful application of the results thereof" is interpreted to be work of an unclassified scientific character and is interpreted not to include national secrets either of a military or atomic energy kind.

2. In section 6 on functions of the Agency, the bill states in point (4) that the agency shall "arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and provide as appropriate for dissemination of data collected; * * *"

Question. How would you define "Scientific Community"?

Would the new Director of the Space Agency disseminate data in line with the policies of the State Department and AEC?

What arrangements would the new Space Agency make with other Government bodies in implementing cooperation with other nations and the dissemination of data? What would be its official relationship with the Soviet Union?

Answers. "Scientific Community" means all scientists interested in research in this particular field (aeronautical and space sciences) and organizations of, or representing, such scientists. "Scientific Community" would be international in extent unless otherwise restricted.

Dissemination of data by the new Director would be controlled by executive branch policy, presumably an Executive order. While such policy has not been laid down, it could well continue the present Defense Department and AEC responsibilities for the securing of their respective national secrets. In the disclosure of such secrets to other nations or foreign nationals, State Department would join Defense and AEC in establishing policies and procedures. Since the new Space Agency would be primarily concerned with research in the aeronautical and space sciences and not with those applications of military significance, the data which the Director of the Space Agency would disseminate would presumably be unclassified data. Whether the new Space Agency would disseminate such data to other nations and foreign nationals directly or through one of the existing agencies for such dissemination could be properly left for executive branch determination.

As regards official relationship of the new Space Agency with the Soviet Union, this again would be a matter for executive branch determination. As a generality, it can be said that the new Agency would have only such relationships with the Soviet Union or its nationals as might be arranged by the State Department in accord with national policy. Establishing appropriate policy and procedures would be a proper function of the Executive by Executive order or otherwise.

(Whereupon at 5:20 p. m. the committee recessed to reconvene at 10 a. m. Thursday, May 1, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

THURSDAY, MAY 1, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS
AND SPACE EXPLORATION,
Washington, D. C.

The committee met at 10 a. m., pursuant to recess, in the caucus room, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack, Natcher, Fulton, Keating, and Ford.

Present also: George J. Feldman, director and chief counsel.

The CHAIRMAN. The committee will be in order.

The first witness will be Dr. Joseph Kaplan, professor of physics at the University of California, and Chairman of the United States Committee for the International Geophysical Year.

We are very glad to have you with us, Doctor. Have you a prepared statement, or do you want to talk from notes?

STATEMENT OF DR. JOSEPH KAPLAN,[31] PROFESSOR OF PHYSICS, UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIF., AND CHAIRMAN, UNITED STATES NATIONAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR

Dr. KAPLAN. I would like to talk entirely informally. I think I am probably one of the few witnesses you have had before this committee who can say honestly he is glad to be here, considering the difficulty I had getting here.

The CHAIRMAN. I understand you were up in the air a lot; outside of your years of education and training and so forth, you recently have had an experience where you were up in the air.

Dr. KAPLAN. Actually, it proves dramatically once more the need for the IGY and for a better understanding of the weather close to the surface of the ground, which is perhaps a strange thing to say at a hearing on space, but one of the problems as always in a case of this sort, is accurate short-range weather forecasting and that is still with us, even in the age of space science.

[31] Kaplan, Joseph, prof. physics; b. Tapolcza, Hungary, Sept 8, 1902, s. Henry and Rosa (Lowy) K brought to U. S , 1910, B. S., Johns Hopkins, 1924, A. M., 1926, Ph. D., 1927, m. Katherine E. Feraud, June 24, 1933. Research fellow, Princeton, 1927; asst. prof. of physics, U. of Calif., 1928-35, asso prof., 1935-40, prof since 1940, chmn. dept. of physics and meteorology, 1938-44, director of Inst of Geophysics 1946-47; national Sigma Xi lecturer, 1948-49. On war leave with Army Air Forces since 1940, chmn. panel on geophys. research Sci. Adv. Bd. U. S. Air Force. Decorated for exceptional Civilian service, War Dept ; 1947, Achievement Award from Tau Delta Phi Discoverer of laboratory productions of auroral spectrum and light of night sky Chmn West Los Angeles Co-ordinating Council. Mem Commn. 22, Internat Astron. Union. Fellow Am. Physical Soc.; mem. Am Astron. Soc , Am. Geophys. Soc., Astron. Soc. of the Pacific, Soc. for Research on Meteorites, Optical Society of America, American Meteorological Society, Institute of the Aeronautical Sciences, Tau Beta Pi, Tau Delta Phi, Scabbard and Blade. Republican Jewish religion. Club. West Los Angeles Rotary (v. p. 1937, pres. 1938). Co-author: Physics and Medicine of the Upper Atmosphere, 1951; Across the Space Frontier, 1951 Contbr. articles to Phys Rev and other sci. publs.‡ ☆ [27]

I realize that in your previous hearings many things have been mentioned as far as the satellite program as proposed by the IGY is concerned, its further plans and so on.

I would like to stress one point that I think has impressed me most strongly in thinking about this problem and that is the point relating to the training and the proper use of the kind of young scientists whom we will need to carry out any kind of an effective program in the exploration of space

The related fields, particularly meteorology, upper atmospheric physics, ionospheric physics, and so on, are fields in which there are relatively very few people active.

I have had a recent experience, for example, of turning out one of the most brilliant young doctors of philosophy in this area, only to have him drafted by an applied laboratory at a salary which is approximately twice as much as he would get in any first-class university and, therefore, he was taken out of circulation insofar as developing himself or doing fundamental research is concerned.

The present proposal to expand the NACA into a larger agency appeals to me personally because of a long and pleasant association with the NACA. I know the quality of their personnel.

As a matter of fact, I have had personal experience of them in years past and was associated with them on some of the new problems of the high atmosphere, 20 or so years ago, and have seen the quality of their scientists and engineers.

I think one of the associated problems, however, is that associated with this proposal should be a thorough thinking and complete revision of the research structure and the use of Federal funds in this area.

I would like to specify as quickly as I can what I mean. I feel very strongly that the Military Establishment, the Air Force, the Navy, the Army, must have first-class research laboratories of the quality of NRL, the Geophysics Research Directorate of the Air Force and the Signal Corps Laboratory of the Army.

I think they ought to be as good as any university laboratory.

The military, the people in the Air Force, the Army, and Navy, ought to have available to them the best scientists in the country.

Now, this has been approximated to my intimate knowledge. Since I have worked at or with two of these institutions, the Naval Research Laboratory and the Geophysics Research Directorate in the past years, I think we have been somewhat close to it, but not close enough. Some of the first-class scientists today working on rocket and space problems at NRL and the Geophysics Research Directorate of the Air Force are men whom I would like to proselytize for the university, but I won't do that, because I don't want to hurt the military.

But there are not enough of them and they should be supported in the same sense that the best scientists in the Nation should be.

At the other end of the spectrum are the universities. It seems to me more thorough thought ought to be given to the kind of support the universities must have. We have so few people working in this field, in meteorology, for example, that we are going to be hard put to find first-class scientific talent.

I do not want to take too long in developing this.

In the university laboratories, the military, and industry, you must have first-class scientific talent. In these three areas the role of the

scientists is different. The university scientist trains men in absolutely pure research. The industry scientist works on developing problems, does research necessary there, and the scientist in the military does fundamental research which enables him to give first-class advice to the military.

There is one point I want to emphasize because without this it seems to me no program we have in the field of space, no matter how imaginative and how beautifully supported it is, can be successful.

In the past 10 years I have seen too many young men for whom we predicted great scientific careers picked off by industry, by laboratories other than industry, some of the nonprofit research laboratories, and lost, lost to those 5 or 10 years of dreaming, which produce people like Dr. Pickering, people like Dr. Whipple, and like Dr. Van Allen.

I know this, because I have watched them dream. We have lost them today. As far as I know, in spite of the impact of the first U. S. S. R. satellite, I, personally, have seen few signs of much having been done about it.

I shall be very happy to answer questions.

The CHAIRMAN. Doctor, do you see the need for some kind of agency on what might be outer space?

Dr. KAPLAN. Very definitely. I think that a single agency which will look over the entire program and which, I hope, will be in a position to consult with everybody in arriving at decisions is essential for this program.

In the IGY satellite program, the Department of Defense appointed the Naval Research Laboratory. The Office of Naval Research is manager for the program. They have gotten complete cooperation from the Army and from the Air Force.

You need a single-manager concept for anything that is complex, something that ranges from the problems of propulsion to the problems of, say, interpreting some experiment in outer space which has to do with magnetism or Einstein's theory of relativity.

The CHAIRMAN. Assuming we have a single management, whether we call him a director, administrator, or any other title, in the organizational setup as outlined in the bill which I introduced for the administration, what kind of man should be appointed to that position?

Dr. KAPLAN. I could name one very quickly.

The CHAIRMAN. What qualifications?

Dr. KAPLAN. I think the man who is presently Director of the National Advisory Committee for Aeronautics combines the entire range of qualifications.

The CHAIRMAN. What qualifications, is what I asked.

Dr. KAPLAN. He should be a first-class engineer or scientist. When I say engineer, I mean the sort of person that you associate with schools like MIT or Cal Tech. He should appreciate, of course, pure science. He should be a good manager.

He ought to be able to write the English language well, and be articulate enough and have range enough that he can talk at noon to the Rotary Club of Washington, the United States Chamber of Commerce, or the National Manufacturers Association, in the afternoon to the National Academy of Sciences, and in the evening be able to talk to his children and tell them what he did during the day; a man who has a wide range of understanding of the problems, a statesman, and a scientist.

The CHAIRMAN. Where can you find people with such a broad field?

Dr. Kaplan. You can develop a number of these men.

The CHAIRMAN. He must have a good personality, too?

Dr. KAPLAN. Yes, sir. I could name Dr. Lawrence M. Gould or Dr. Lee Du Bridge as men of that kind. I think there are a number of such men.

The CHAIRMAN. You have permission to edit and revise your remarks. Of course, you can elaborate or clarify them in any way you want to. Is there any consideration to the extension of the International Geophysical Year or period?

Dr. KAPLAN. In some of the areas of the IGY, the results have been so important and exciting to the scientists that both our National Academy of Sciences and the International Council of Scientific Unions have appointed special committees to continue this work after the IGY. This is in the fields of oceanographic and Antarctic research. Both international and Academy committees have been set up for the latter.

The IGY Committee has already recommended to the president of the National Academy the appointment of a continuing committee on rockets and satellites in the Academy, and we hope that a similar one will be appointed, worldwide.

I happen to be president of an association, international association, dealing with the upper atmosphere, and am now planning to set up a subcommittee on problems relating to the physics of space.

In many of the major areas of the IGY, results have been so stimulating that, in order to save time, planning by groups other than the United States National Committee for the IGY is now going on. This time both on the national and international side.

The CHAIRMAN. It does create a sort of healthy atmosphere, I imagine, for a discussion and exchange of views.

Dr. KAPLAN. Actually, the USNC–IGY is playing a sort of interim role in helping to carry over from the actual IGY. The result has been an extremely healthy international atmosphere.

The CHAIRMAN. Of course, there are many interesting questions involved. It involves sovereignty of the air; there is international law.

Dr. KAPLAN. We are aware that people have been thinking about it, but, so far as the IGY is concerned, no question has been raised in any of our relationships with other nations as to sovereignty or who owns space.

The CHAIRMAN. I understand that, but my question was that those intricate and interesting questions still exist?

Dr. KAPLAN. Yes. There are a number of very able people who are dealing with this question of who owns space. Dr. Cooper, at the Institute of Advanced Studies, in Princeton, an oldtimer in the field, a very eminent man in the field of aviation law, has done a lot of thinking in this area.

The CHAIRMAN. I understand he is going to appear before the committee.

Dr. KAPLAN. Yes.

The CHAIRMAN. This is a virgin field now that the world is entering into. No one knows, I suppose, where it is liable to end. There is a great unknown out of which will flow new discoveries. Would this be a good time for the nations of the world to try to establish plans

for peaceful exploration of the outer spaces before there is an intense, competitive race along military lines, or wait until later?

Dr. KAPLAN. I certainly feel strongly, or I would not have devoted so much energy to the IGY, regarding the importance of worldwide cooperation in matters dealing with our environment, whether it is space, the atmosphere, or the oceans, or the solid earth, because no one nation can get the data and information alone. You need international cooperation for the benefit of everyone. I think that the continuation of the pattern that the Geophysical Year has set would, indeed, be a fortunate thing for the world.

The CHAIRMAN. You may elaborate on that. I wish you would elaborate on your views as you edit your remarks.

Dr. KAPLAN. Naturally, because of my role in the Academy, and the International Geophysical Year, I have been thinking of all of the scientific aspects of this program.

Back of it is a strong feeling, which I try to present whenever there is a good audience to listen to it, that the finest defense of a nation is to have a stockpile of information about its physical environment, particularly at at time when its military technology is changing so rapidly.

In other words, I, for one, if practical, would take a large portion of money spent for defense and put it into pure research and be satisfied that I was helping to defend the Nation effectively in these rapidly changing times. My reason for saying that is that I have lived through active years of research in which I started the excitation or the production in the laboratory of one of the unknown features of the aurora borealis, the northern lights.

Thirty years ago, anyone who worked in that field was looked at as the purest of all scientists. Today, the northern lights determine the behavior of the high atmosphere; the descendants of the work I started 30 years later determine the safety of flight over polar routes or the safety of a nation.

In fact, I am on my way to San Francisco to speak to a large group there. The title of my talk is "From Spit to Sputniks," or the story of one spectrum line due to an atomic oxygen, from pure theory to combustion spectroscopy, to rockets.

What goes on in the high atmosphere, what are the winds at an elevation of 100 miles? The exploration of nebulae, our understanding of the sun's corona and even some of the current experiments in the field of the application of hydrogen fusion to peacetime efforts, are related to the kind of laboratory experiments, that I started some 30 years ago.

When you have lived through a period beginning with a highly academic excitation and production in the laboratory of the aurora which occurs in the northern regions at heights of 100 miles, or so and see it 30 years later as 1 of the key problems in which men of science are interested, then the point that Dr. Berkner made regarding the extention of our efforts to higher altitudes, and the finding of new things there, proves that no one can be extravagant enough to overstate the case for this program.

Also, man advances as he gets off the ground. He first learned to sail the seas, then he learned to move under the oceans, and he has learned to move higher and higher in the atmosphere.

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When I say that man advances, I am talking about the study of man himself, his spirit, his music and art as well as his science.

When you give him a new tool for looking at the universe, you are creating a new kind of man.

Incidentally, I am not an expert on the physics of space. I am just the person who tells them what they meet on the way out there. I think some of the people who are reporting now by the way, at the National Academy, are the most courageous scientists in our country, men who are accustomed to instrument rockets and satellites, having a year's work blow up in their faces, and then have the newspapers say that they failed, but then come back and do the impossible 2 months later.

The CHAIRMAN. Mr. Natcher

Mr. NATCHER. Dr. Kaplan, have you had a chance to go over the bill that is now pending before the committee?

Dr. KAPLAN. I went over it before I left for abroad and I went over it again last night. I am 7 hours behind schedule so I have been working since 3 o' clock this morning.

I personally think it is an excellent bill provided the people who carry out this function have the courage to recognize the fact that I tried to point out earlier, that first-class scientists at universities and military establishments are absolutely essential, if the money is going to be properly spent.

I have no quarrel with any proposals. I am not a manager.

Dr. Berkner is a more experienced manager. I am simply a teacher of physics, who teaches anybody from a Rotary Club member to an elementary student.

Mr. NATCHER. Dr. Kaplan, if you were in a position and had the right to select the Director of this new Space Agency, what type of individual would you select? Would he be a scientist or would he be a man successful in administrative duties, or what type of individual would you select for the director of this new National Aeronautics and Space Agency?

Dr. KAPLAN. I might say in answering this that I have had the personal experience now of heading one of the largest scientific efforts the Nation has ever made.

I could not have carried out my duties as chairman of the USNCIGY except for a remarkably devoted staff, particularly an executive director, Hugh Odishaw, who is a very good scientist, has engineering training, very articulate, knows the Government problems, and has good sense.

I think if you can get a first-class scientist and have in him the equivalent of an executive vice president of a company, who is a good, hard-boiled, sensitive character, a man of integrity, who knows how to manage his staff and yet has the stature to grow with the program, you have solved the problem.

Mr NATCHER. Dr. Kaplan, the Space Board provided under the bill is to consist of not exceeding 7 members. How does that number appeal to you? Is it large enough or too small, too many?

Dr. KAPLAN I do not think it is too many because as I recall the constitution of the Space Board, it represents people from many agencies who are interested and this requires a large board.

Mr. NATCHER As you know, Dr. Kaplan, in examining the bill it provides that 8 of the 17 members shall come from 8 different de-

partments of Government. That is on page 3 down at the bottom of the page.

Dr. KAPLAN. In this way it is similar in principle to the NACA.

Mr. NATCHER. Yes. That is correct.

Dr. KAPLAN. I think this has worked out very well, Mr. Natcher.

Mr. NATCHER. It also provides that at least one of the members shall be from the Department of Defense. In your opinion should each branch of the military service be recognized on this Board? Should there be one from the Department of the Army, the Navy, the Air Force, or would one from the Department of Defense be sufficient?

Dr. KAPLAN. I would really say that one from the Department of Defense probably would be enough. I feel from the experience that I have had with the IGY satellite program, that the existence in the Department of Defense of the special committee advising one person, Mr. Holaday, and carrying out the functions of monitoring the Vanguard and Explorer programs, has been very effective.

I am a member of that committee, by the way. In no part of my experience with the Vanguard or Explorer have I seen any reluctance or any difficulty on the part of any departments in cooperating with a single person in the Department of Defense.

I like the concept of someone from education and public affairs on the Board. The impact of the IGY satellite program on education alone, what it has done to the reexamination of education and so on, has been to me a worthwhile and a satisfying experience.

The increasing need for having a scientifically informed public in the United States means that somebody from education should be on a program that is as daring, far-sighted, and new as this program is.

Mr. NATCHER. Dr. Kaplan, from time to time we hear statements to the effect that here in this country we are not exchanging scientific knowledge with our allies. This gentleman sitting on my left is Mr. J. E. B. Hill, a member of the House of Commons of our ally, Great Britain; now, how do you feel about our exchanging scientific knowledge in this country with our allies as we should and, if we are, what accomplishments are we receiving?

Dr. KAPLAN. I could speak authoritatively only in the field in which I have helped to advise the Department of the Air Force. I have been a chairman and member of the Scientific Advisory Board's panel on geophysics for 11 years. The fact is that in the rocket program of the Air Force, the Army, and the Navy, in which we use high altitude rockets for probing the atmosphere, from the very beginning the military and this Nation released all the information.

In fact, until the rocket and satellite meeting at the Academy last October, which was followed by the announcement of the first Russian satellite, until that time, so far as I know, we were the only nation that had used rockets for upper atmospheric soundings and published all the information freely.

The result of that was that theoretical physicists and geophysicists, particularly in England, Drs. Bates and Massey, Dr. Nicohlan, Belgium, the present secretary-general in the IGY, dozens of men, men from our allies and men on the other side of the Iron Curtain, were able to take this data and analyze it. We were relatively new and weak in the theory and they were strong, and the net result is that our rocket program improved and today we are doing things with

rockets in the Antarctic and at Fort Churchill that even I, with not a fettered imagination, would have thought impossible a number of years ago.

We are literally firing a chemical analyst up there in the form of a mass spectrometer—sucking the air and determining its composition while the rocket goes up, turns around, and comes down.

We could not know this information unless the information were freely published.

On the other hand, I think in the world as it is today I think judgment has to be exercised on these matters and this is a very difficult problem. In the case of the country that you mentioned, Great Britain, I told our distinguished guest today that I like to stop in London just to be able to read the Manchester Guardian and the London Times I like England and our ties with British science are particularly close in this area

The British are now firing rockets of their own in Australia at the Woomera range, for the IGY.

I should certainly think that in as many areas as possible free exchange among nations benefits us.

Mr. NATCHER Thank you, Dr. Kaplan.

The CHAIRMAN. Doctor, on page 6 of the bill, on line 3, it states: "Arrange for participation by the scientific community in planning," and so forth.

What is your opinion as to the interpretation of the words "scientific community"? More directly, is it confined to the United States, or worldwide?

Dr. KAPLAN. I would like again to use the Geophysical Year as an example, because it is current and I think it is well known.

In the Geophysical Year, in introducing a group this morning to report on preliminary results of Explorer No. 1, our first satellite, they are talking right now—I emphasize preliminary results—I pointed out in introducing the Chairman that the five speakers came from the California Institute of Technology on the Pacific coast; the State University of Iowa, the Geophysics Research Directorate of the Air Force up in Cambridge; the Naval Research Laboratory down the road here, and then at Harvard, the Smithsonian Astrophysical Laboratory; industry's Dr. Porter, the Chairman coming from GE; this industry, university, Government laboratories—the whole country represented.

I think that the National Academy of Sciences will take the responsibility for continuing its advice to the Nation in this area as it has taken the responsibility for administering and directing the IGY and it certainly represents the entire scientific community.

If this new Space Agency goes to the Academy for this advice, then there should be no difficulty in working with the scientific community.

Secondly, where the talent exists among scientists of other nations, and here I think it is natural that we deal necessarily with scientists of nations with whom we have been associated for a long time, we should include them as part of the concept of "scientific community."

The CHAIRMAN. You would interpret that as being on the world level?

Dr. KAPLAN I would interpret it as being on the world level, but practically, from the point of view of our own Nation and its advancement in these very difficult times, as being primarily on our own

national level, with the extension to the rest of the world as the situation develops.

Mr. NATCHER (presiding). Mr. Fulton.

Mr. FULTON. I want to welcome you here as one of the distinguished scientists, not only of the United States, but the Western World, and the whole world.

We are proud of you and we hope your contributions to this subject on basic research and physics will continue.

We Americans are very lucky to have had pioneers against a cold public opinion rather than an adverse public opinion. They have persevered just as they always have through the years and now these activities of you and other scientists are coming to fruition and Congress has taken recognition.

I explain and apologize to you for the 8-hour delay which you had, partly caused by the weather and partly by a misunderstanding at the Washington Airport.

Dr. KAPLAN. I appreciate that, Mr. Fulton, but I think even an atmospheric physicist occasionally can stand a reminder of what the problems are. I must say this was a very drastic reminder.

Mr. FULTON. The weather predictions we need and we hope some day to have the satellites which you people send up which will give us the kind of weather that all the Congressmen will vote for.

I know the two inspectors down at the Washington Airport do a very excellent job. We Congressmen go in and out a lot and we have gotten every courtesy.

As a matter of fact, I called Mr. Swing's office this morning and had Joe Waters, legislative counsel, come over here especially and give you a written explanation of how the thing occurred at the airport. So that is available to you on a personal basis, if you like.

Now, we have with us a distinguished visitor whom I would like to introduce with the permission of the chairman.

Mr. J. E. B. Hill of the British House of Commons is with us. He is a Conservative member of Parliament, representing South Norfolk. He is sitting on the Democratic side.

Mr. NATCHER. If the gentleman will yield—which is the proper side, I believe.

Mr. FULTON. The gentleman, Mr. Hill, says he usually sits on the right in the House of Commons. He is a graduate of Merton College in Oxford and is a barrister and farmer by background.

He was elected to Parliament in the bielection in 1955, and is one of the few people of an official capacity from a free government in the Western World who has visited Communist China. He was there in 1956.

Mr. FELDMAN. Congressman, do you think it is a rare thing to have a conservative Democrat?

Mr. FULTON. I am very glad to know that the Democratic Party and the Republican Party have room in them for both conservatives and liberals and that by a certain uniting of the minds they do get the programs through.

Now, I put in the record the background of Mr. Hill and welcome him to the committee.

Now, Dr. Kaplan, we are coming to the end of the International Geophysical Year, the problem comes up: How shall we continue the programs that we have initiated and that are interesting, not only to

the United States but the world, which we in Congress now believe should be proceeded with promptly?

For example, our United States Vanguard program, because it has been a program under the International Geophysical Year, will probably automatically expire without further congressional authorization.

What should we do? Renew the International Geophysical Year, try to reinstate it when the nations have decided they are probably not going along with it, or should we just start individually on a national United States space policy and then try to get international cooperation?

Dr. KAPLAN. There are international scientific unions as you know. Dr. Berkner is the president of the International Council of Scientific Unions. In these international unions, such as the one I am associated with, the Union of Geodesy and Geophysics, of the International Astronomical Union, there are provisions for continuing international cooperation and they will inherit, in my opinion, and should inherit, a great deal of the planning and thinking and the followup that should follow the International Geophysical Year.

We should as a nation, I think, do our part in those areas in which our cooperation is required.

For example, in rocketry and the use of rockets or satellites, or in oceanography. The ocean covers 75 percent of the earth, to give you an example, intimately connected with the weather, with the food resources of the world.

It is to our benefit to cooperate with the other nations and to continue to learn about the oceans whether in the area of purely peaceful knowledge of the oceans, or the part of it having to do with our defense.

Now, there are mechanisms, following the example set by the IGY, through which the National Academy can appoint a committee, in any field. These committees can go to the Congress through the National Science Foundation just exactly as we did in the IGY, and make sure that American science in its broadest context, industry, Government laboratories, et cetera, can take part.

I think the pattern is set and should be followed. It would be most unfortunate if this pattern should be short cut.

Mr. FULTON. That brings up a question. If we in Congress establish a new Agency that will be called in effect the National Space Agency, to have the primary jurisdiction and set the policy on space, both astronautics as well as aeronautics, should we then on this Space Agency have a setup so that the international aspects of the problem can be dealt with through that mechanism?

Dr. KAPLAN. I think it is very important that the Space Agency have a setup so that they will consult the Academy which represents the national and international bodies. I think it would be a bad step if we did not.

We have set, it seems to me, a remarkable example of international cooperation already and I think from any point of view, the purely hard-boiled scientific point of view, or any point of view you can look at, it seems to me that a good, decent, imaginative international attitude of this Nation will in the long run redound to its benefit.

The Academy is organized to help achieve this.

Mr. FULTON. You feel that the International Geophysical Year participation of the various agencies of the United States has been

worthwhile, first, and, secondly, that we should continue by some means an expanded international program on space matters through various United States agencies?

Dr. KAPLAN. I would agree with that. I think it is very well stated if I may say so. It is clear.

Mr. FULTON. May we ask you, too, Dr. Kaplan, your judgment on the effect of the IGY? Has that been to open up a whole new area of thinking in the world? That means before and behind the Iron Curtain. And has it also been a stimulant to the scientists of the world to cooperate on the exchange of basic information for the future progress of the world?

Dr. KAPLAN. I can give broad examples and special examples. Perhaps the most dramatic special example is the Weather Bureau in the Antarctic in which the 12 or 13 nations, including the U. S. S. R., participate. There is a Russian scientist there. One of our scientists is at their base. The United States Weather Bureau operates a Weather Central for the United States National Committee in the IGY and in turn for the rest of the world and it is the first time in history that two daily weather maps are issued for 6 million square miles with average high-altitude soundings last season up to around 65,000 feet.

The value of that no one will know until the analysis of the research phase of the IGY comes and we are now planning in order to make certain that such analysis and research does not lag.

Eventually you have to start thinking and planning. My own hunch is that the impact of the Antarctic cooperation will be so great that the nations of the world will want to continue this just from the point of view of weather alone.

Mr. FULTON. As we have a member of the British Parliament here, we might discuss our relations shortly with the Government of Great Britain in this field.

We in the United States are setting up a committee in each House, one in the Senate, one in the House of Representatives, to handle space matters from the legislative point of view, and so far have been aiming at the establishment of a civilian space agency.

Do you think that we in the Western World, and especially between the Governments of Great Britain and the United States, should have a closer liaison on these matters and second, because between Britain and the United States we do not have enough scientists to do the job or compete successfully at this point, that we should avoid duplication and share our joint scientific assets and resources?

Dr. KAPLAN. That is a difficult question. My own personal feeling would be yes, because of the close relationship between the two nations.

On the other hand, in the whole pattern of the IGY there have been many relationships between two nations, bilateral relationships. They have established it themselves.

In these terms your suggestion would be entirely fitting.

I do not think that the relationship should be just with one nation, but there are many natural reasons for bilateral agreements.

Mr. FULTON. Actually, your position and mine is that there should be a broad base of general knowledge which we give to the world from the United States and cooperate completely with the world. My

question refers probably to the missile programs and rocket programs that could be both for peaceful and military uses.

In those particular programs, I am sure there is no use of Britain shooting up and trying to make the same kind of rockets we already have.

Dr. KAPLAN. Actually, in the IGY, the cooperative effort in the rocket field was such that when the British, particularly the Japanese, decided to try a rocket program, we invited the Japanese scientists to visit us. We cleared it with the Government, the Naval Research Laboratory, Signal Corps, Air Force; they were extremely hospitable.

As a result, the Japanese have contributed to the rocket program. We have had the same relationships previously with the British, but entirely in the area of instrumentation of the rockets.

To the scientist, the propulsion of the rocket is a matter of importance, of course, but not a matter related to science.

For instance, if I want to go down to the Antarctic to make observations of the aurora there, I am not at all concerned about the icebreakers or their techniques or the ships that take me down or the airplanes. I just want to get down there.

On the other hand, it is not quite that way in the rocket field. It is necessary to cooperate closely with the men who design it so that your instrumentation can withstand shock and acceleration and things of that sort, and there has been close cooperation.

There is a beautiful example, by the way, at Fort Churchill where the Canadians and the United States jointly operate one of the most remarkable rocket-launching facilities, I think, in the history of the world, in that Arctic desert waste. Some of our most successful high-altitude soundings have been carried out there.

The cooperation of the Canadians is really generous.

Dr. Davies is an old friend of mine who showed me around when I went over there to help dedicate the facility with General Gavin. I asked Davies, "Have you left any space for the Canadians?"

To the extent to which it is possible, I would say the closer the cooperation, the more money you save and the more likely it is that you will get the answers.

Mr. FULTON. That is good news for our taxpayers.

Dr. KAPLAN. I would think for the IGY it has been fortunate, but in space physics, space explorations are an extension of it; we are in the position that the pure scientist in the best sense of the word is also a practical man. Weather is a challenging problem. Oceanography is a challenging theoretical problem that defies solution. Yet men's lives and their economy depend on it.

So we are in a very fortunate stage there. We do not have to justify the practical values of the geophysics.

Mr. FULTON. May I say to the good doctor that you can edit your remarks or change them as you wish in the testimony because we want the testimony to be your considered judgment, not your offhand opinions.

Secondly, would you make a statement for the record for us later, with the chairman's permission, that will include our participation and that of Soviet Russia in the IGY? Give us a short history of the relationships and how it worked out?

Mr. NATCHER. Mr. Fulton, as I understand, you want Dr. Kaplan's statement to be short, in other words, a brief statement, for the record. Without objection, it is so ordered.

Dr. KAPLAN. If it is agreeable with the committee, Dr. Sheldon, I am quite sure, can get in touch with Mr. Odishaw and he will be very happy to edit, since I will be out of town.

Mr. FULTON. Likewise I would like a summation from you in outline of the accomplishments that you think the IGY has made, particularly in reference to the United States. as well as to the world at large.

But if you would relate that to our own country particularly, I think it would help us from the Congress' point of view.

(The material referred to follows:)

SUPPLEMENT TO TESTIMONY OF DR. JOSEPH KAPLAN, CHAIRMAN OF THE USNC-IGY, BEFORE THE HOUSE COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION, SUBMITTED AT THE REQUEST OF MR. FULTON

It is of course very much too early to assess the accomplishments of the International Geophysical Year. Such an assessment can properly be made only after all the data which is even now being obtained has come in and then only after the scientific community has had an opportunity to digest and redigest the data.

However, even within the first few months of the IGY program it became apparent that this highly intensive effort was reaping preliminary results beyond our fondest expectations. Successful technical innovations, as well as actual findings, began to come in in some quantity. Some of these were based upon IGY work that had been performed in the months prior to the formal opening of the program. Much of it came in the next few months. I should emphasize that in both cases the results I am talking about are entirely preliminary. They are the kind of thing that one grasps even before full analysis of data. When these data are fully analyzed, it may be that some of these preliminary findings will be modified or enlarged.

I believe that a good picture of these early accomplishments can be obtained from the attached report from the January 17, 1958, issue of Science, the publication of the American Association for the Advancement of Science. The report was prepared by Hugh Odishaw, Executive Director of the USNC-IGY. It summarizes findings reported by the institutions and scientists participating in the IGY during the first 5 months, principally in the United States program, although there are repeated references to projects conducted in close cooperation with the national committees on other countries.

Since the publication of this report we have had indications of continued results in the same pattern. Then of course there are the very dramatic results reported on the very day of my testimony before this committee by those scientists who prepared the experiments for 1958 Alpha, the first US-IGY satellite. Among those findings were the very exciting results obtained by Dr. James A. Van Allen of the State University of Iowa who is Chairman of the IGY's Working Group on Satellite Instrumentation and who prepared the cosmic ray experiment carried in 1958 Alpha. Van Allen's findings, again preliminary, indicate that there is a hitherto unsuspected belt of solar radiation, a thousand times more intense than was expected, lying in a region about 600 miles above the earth. This is a highly important factor which will have to be considered in future space work.

Dr. KAPLAN. We are actually doing it in the satellite field this morning at the Academy. I will be back next week and will personally read the testimony.

Mr. FULTON. Let me just finish with this.

You do favor the creation of a new space agency to have primary jurisdiction to set a national policy for space. If necessary, to have a new agency?

Dr. KAPLAN. I would think that, in view of the tremendously complicated, rapidly changing picture, that I have seen in the past, which has occurred only in the last year, and many other factors, and I think in view of the success that the NACA as an example, has had, I think the creation of a new agency which is essentially a very great extension of the NACA, is a wise move. Again, however, with

the proviso that we have already discussed, that all the talents of science be used most economically with the view of using scientists well and not letting our good young men waste their talents.

Mr. FULTON. You firmly recommend this be a civilian rather than a military agency; is that correct, and not be subject to the policies of the Department of Defense in effect?

Dr. KAPLAN. Yes. I think if I were a propagandist from the Department of Defense and had their welfare in mind, I would feel very strongly about having it a civilian agency.

I think that most of my friends in the Air Force, Navy, and Army, particularly the Air Force, with which I am closely associated, feel this way. They have excellent records in the way they have used civilian agencies or civilians for research. I think they, too, should welcome this approach as being the most effective by which their problems will be solved.

Mr. FULTON. Thank you very much, and you have made an excellent witness.

Mr. NATCHER. Mr. FORD

Mr. FORD. Dr. Kaplan, I notice that you are United States Chairman of the National Committee for the International Geophysical Year. It that an appointment by some person, or agency of the Government, or is that from the scientific community itself?

Dr. KAPLAN. This is not too often understood, but the organization in the United States, or the entity which is responsible for United States participation in international scientific affairs, is the National Academy of Sciences, and when the International Council of Scientific Unions decided to sponsor the IGY, they went to the academies of all the nations for help. In Great Britain, for instance, they have the Royal Society in London which is the analogous organization. It is private, it has a charter, it is charged with advising the Govern-in scientific affairs.

The Academy appointed a committee. My well known ability to travel and to suffer the vicissitudes of such things as I did the other day and still come up smiling, I am pretty sure was the principal basis for my selection as chairman.

Presumably science had something to do with it. I accepted the chairmanship 5 years ago and in view of the tremendously exciting developments that have occurred in spite of the vicissitudes of the job, I haven't regretted it.

It has been an historical 5 years for the Academy and I am sure for the Nation.

Mr. FORD. We had a witness a week or so ago who was asked the question whether or not we should extend almost immediately the International Geophysical Year. As I recall the testimony, the recommendation was that maybe we ought to have a period of time lapse in order that the scientific data collected can be properly evaluated before inaugurating another IGY, this being the third one.

What is your comment on that?

Dr. KAPLAN. I would certainly agree that we need a period of time for analysis and research and for the development of men who have gotten interested in this field. The way science progresses is that bright young men go in the most exciting directions.

If it turns out that the data of the IGY, say in meteorology, oceanography, gladiology, all of which are related—they deal with heat, water,

and ice—if that gets exciting for some smart young theoretical physicist or chemist, I think that is where they will go. I think we have enough data to have excited these people.

In the meantime, we cannot afford to neglect or to allow a hiatus in the stress of those areas which we have developed and are staring us in the face. We get new information on the structure of the earth, the amount of ice, its depth, its distribution, and if it is important for the scientists to have that information, we should not arbitrarily wait for another sunspot maximum.

I think it is a matter of judgment. The spirit of the IGY, the spirit of the international cooperation, and the advantage of having nations work together, I think is going to carry over into other fields so that this will stay with us.

I do not like the word, but if we have a breakthrough somewhere, we certainly will not wait for the sun to come around and act up again to go through this business.

May I add one more point.

The impact of man's physical environment on his technology, on his way of life, is increasing almost exponentially. You could live with the weather a few years ago much better than you can now.

Because of high speed of flight, the character of most of our operations, a knowledge of our physical environment is far more significant and, consequently, we cannot neglect it. We cannot wait for another IGY to find out whether you can safely dump atomic wastes in the ocean and hope you will learn about circulation sometime in the future.

In the meantime, you may be destroying the food for future generations.

These are areas in which I think we have to have good judgment and the best judgment—this is why I like the structure of your Advisory Board—the best judgment in my opinion is all the people in the United States, as many as possible.

If you have a representative board, they are literate and they are knowledgeable, I would like it better than to have a board consisting of nothing but specialists.

Mr. FORD. In other words, you would prefer a board of 17 or a reasonable number as an advisory group in preference to a set commission type of 5 members or 7 members on a full-time basis?

Dr. KAPLAN. I think in view of the broad character of this area, yes.

In this particular area I would prefer the board type of operation as presented in the bill.

I might say in saying this I do not want to imply any adverse comment on the AEC. It is completely outside my area of competence.

I think I like it because I am very sensitive to the way in which the IGY has affected thinking of children. I have experienced a half dozen cases where people have asked for my autograph. Now, coming from California, that is a striking example. These children are excited.

I think the public has a right to be in on science and understand what is possible and we get good advice from men who come from areas other than the restricted areas of science.

Mr. FORD. Doctor, I know for some years you have acted in an advisory or in a consultant capacity with the various departments, the various constituent departments of the Department of Defense.

Has that been on a contract basis through the university, or has it been on a per diem basis?

Dr. KAPLAN. It has been on a per diem basis on a personal contract. On occasion there have been cases where there were special studies during the summer. I think most of the members of the Scientific Advisory Board who come from private life, as I do, and from the universities, are on this contract with ARDC.

Mr. FORD. I ask that because in the legislation there is a provision which says:

To obtain services as authorized by section 15 of the act of August 2, 1946, at rates not to exceed $100 per diem.

We have had in the past on the floor of the House and in committees, discussions whether $50, $75, of $100 per diem is adequate.

Would you care to comment on that?

Dr. KAPLAN. I first came on the SAB with Dr. von Karman as chairman. He is still the best aeronautical scientist in the world. I considered it a great distinction to be associated with that group. At that time we had nothing except the relatively inadequate per diem of $10, or $6 a day. Even then you could not stay in Washington at some of the hotels which I will not mention, for that sum, but I found this was part of my job.

I was a university professor. If I wanted to make money I would not have gone into the university. I do not know what they meant by it, but recently when I spoke to the National Association of Manufacturers, a trade journal referred to me as the best salesman they had ever heard. I hope they meant it well.

One does not do this for money. When the $50 a day business came in it was good.

In my own case, and I suppose it is true in other cases, I have avoided ever allowing myself to be used as a consultant by any private organization. I am in the area of great industrial activity in this field. I have done it with full awareness that I could resign from the SAB, but I like the Air Force; it is young, vigorous—it operates increasingly in the media in which I do my science. They have been very cooperative. They do not always do what I tell them, but what I tell them is not always right.

Consequently, I have been happy in my Air Force association, but I do not think from a cold-blooded business point of view the fee of $50 a day is a realistic fee from what I hear. I have not experienced these other fees and do not intend to while I am still on the SAB.

On the other hand, there is such a thing, particularly in these difficult times, as pride of country; we are citizens first, scientists next.

I have not found it any disadvantage to have been a college professor and adviser to the Air Force at this relatively small per diem. I have found the work exciting, the Air Force receptive.

I think General Keirn will testify that they like me.

Mr. FORD The amount should be adequate, but it really is not the incentive that makes talented people come and do the job.

Dr. KAPLAN. Frankly, you cannot buy the services of these people. You should not have to, it seems to me, in a case where it is for the welfare of the Nation.

Now, when I was asked recently to appear on a television program, and I want to go on the record on this, the assumption was that being

a college professor I would appear for nothing. This was a sponsored program. First of all, I would not appear on a sponsored program, generally, because of my position with the Academy.

Secondly, I simply asked them "What do you pay your most highly paid comedian and that is the fee for which I will appear," because I thought I was reasonably enough conceited that I was just as good as a teacher of scientists as some comedian was a comedian.

Naturally, they did not employ me.

But that is a sore point with me.

Mr. NATCHER. Mr. Feldman.

Mr. FELDMAN. Doctor, what are the possible scientific advantages and practical consequences of an adequate space program?

Dr. KAPLAN. The answer to a question like that, I think, depends on the scientific experience of the person. I would rather answer it from my own experience.

As I look at the history of astronomy and its impact on our technology, and earlier I mentioned a relatively minor aspect of it in the study of the aurora, but when one looks at the history of astronomy, it was the attempt to understand the source of energy of the sun that led to the development of the theory of hydrogen fusion that would eventually, I hope, lead the world to the development of its greatest single source of energy.

Now, what will happen in the biological sciences when life is studied in new environments, I don't know, but my guess would be that equally exciting results may very well come out.

Mr. FELDMAN. What role should scientists in the Department of Defense play in this space program?

Dr. KAPLAN. I enlarged on that point a little earlier. The emphasis again, I think, I will put on the role of the young scientist that is working on his doctorate, who wants to develop into a scientist on his own and wants to determine his own way of life and so on, his own areas, and I would say in this particular program that these young scientists should be adequately supported and given a real opportunity to work.

Now, they will be associated with the more experienced people like Dr. Van Allen, Dr. Whipple, and others who are now working in this field and I think they can contribute a great deal. Every possible help can be given to these men because they work and think in probably the best environment of scientific thinking we can have.

Mr. FELDMAN. During the course of these hearings, Doctor, it has been stressed time and time again that the need for training new scientists is uppermost and most important. In that connection what is being done to establish what I would call a seed crop from which other scientists could be developed.

In other words, it seems to me that when the universities train extremely able young scientists, that those scientists could in turn train a number of other scientists and in that way we build up a great scientific force.

Now, if the Government and industry recruit what I call the seed crop and they are not in a position where they can in turn teach others, then we are plowing under the seed crop.

How would you go about developing a program which would insure us of a large force, if you want to put it that way, of scientists?

Dr. KAPLAN. In the field of rocketry, it started out that first-class work and development of good young people has occurred both in the Defense Department laboratories and in the universities, with some exception perhaps in industry. This has been a rather exceptional phenomenon. I think one puts it a little strongly, and perhaps I did it also, that industry plows these men under, because there are known exceptions. Men in industry have won the Nobel prizes, the transistor was developed by the people at the Bell Telephone Laboratories. These are notable, but exceptions. In general I think scientists in industry would be the first to admit that the universities are the best way to develop good young scientists because that is exactly where they go to get their people.

I think it is shortsighted when a first-class young man is allowed to go into industry before he has a chance to teach, to do research and to show whether or not he is going to be one of the real scientific leaders of the future.

I think the solution to it is pretty practical. Pay him a reasonable amount. Don't ask a young man with 2 or 3 children not to be able to have 2 or 3 more or to live on an economic basis where he is worried at the end of every week whether or not the budget will balance.

But give him a reasonable chance at peace of mind which you need to dream and think, as increasingly is being done.

I frankly do not think that anyone in the country as yet has been sufficiently imaginative in this area. I do not speak for myself because I am one of the oldtimers. I speak for the good youngsters.

Mr. FELDMAN. I was thinking more in terms of training one good scientist in this field, who was able to impart his knowledge to others, that they, in turn, could train 4 or 8 more and those 4 or 8 more might be able in turn to train 4 and 8 more each, and so on.

In that way in a relatively short period we should be able to build up our scientific background.

Dr. KAPLAN. We are doing something in that area. The National Science Foundation's scholarship program helps. But we are not, in my opinion, strong enough and imaginative enough and courageous enough in this area. It is not a very expensive item.

Of course, commenting on the high schools, there I think we simply have not faced the problem at all. There has been a lot of talk, a lot of discussion, lots of opinions, but I have not seen any school district as yet that I know of that has taken the kind of action which will attract first-class people to high school teaching.

There has been a lot of talk about doing things in this field and I guess there has been some action. I think basically it starts with making it attractive enough by rewarding those with special knowledge by special compensation.

The very men who criticize our high-school system are men who do not recommend that their best students teach in high schools. This is unfortunate. They cannot really do it. There is no opportunity in high school to develop into a first-rate scientist.

With some of the tremendous, perhaps necessary, bureaucratic control of curriculum makers, et cetera, it is probably pretty difficult to develop into a first-class teacher in some high schools.

How can you develop into a great teacher under circumstances where you have no room even to experiment with your teaching,

let alone have a little bit of equipment or opportunity to get in touch with nature, itself?

Mr. FELDMAN. Is there anything being done to correct that?

Dr. KAPLAN. There are a lot of meetings going on and a good portion of my time goes to talking to teachers and to school students and curriculum makers and so on. They are thinking, they are worrying about it.

I think the impact of the U. S. S. R. satellite on subsequent thinking has created an atmosphere of at least healthy concern. I understand there are many bills before the Congress. How basic they are, I cannot say except that I have the feeling that they are not as courageous and as basic as they should be.

Mr. FELDMAN. Is not the interest subsiding in direct ratio to the fact that the sputnik is no longer in the air and there does not seem to be one, at least there has not been any talk of one, in the immediate future that will be as sensational as the two others that did go up?

Dr. KAPLAN. I am sorry; I did not hear the question.

Mr. FELDMAN. In other words, the interest seems to be subsiding now because of the fact that the Russians have not done anything sensational in recent months.

Dr. KAPLAN. I think it is more basic than that. I think it is a very difficult thing in these days of sciences that are essentially removed or esoteric for even intelligent laymen to understand science.

Very few scientists have the skill, have developed this skill to make the layman understand them. There are increasing numbers of television programs, and I think they have done a fair job of reaching the public, but it is very difficult to reach them with these basic facts, the simple facts, the fact that when a man drops a magnet into a coil of wire a galvanometer deflects and that this led to the development of new industry and a profound change in our way of life.

You have to tell them that story again and again.

Out of a thousand scientists who will be leaving this week after the meetings in Washington, not many are able to tell this story. They have not had the training. They are beginning to get it. They are beginning to respect the man who can tell this story.

Up to now the men who commanded the respect were the research men, occasionally a really great teacher.

But the popularizer of science who has to create a great articulate; literate public, was not receiving the Nobel prizes; was not receiving the acclaim. He is getting it now. Until we get it only the very sensational things will attract attention.

We are in a period, I think, of evolving into a nation of really intelligent people. I am glad that IGY and sputnik had something to do with it.

Mr. FELDMAN. How did the IGY arrive at the decision to recommend the earth satellites?

Dr. KAPLAN. It was really a simple idea. We had included rocket programs for the study of high atmosphere. A rocket, you know, goes up, turns around and comes down after spending a few minutes in the high atmosphere. Rocket soundings are difficult; it is restricted to 1 region or 1 station.

You do not see the whole world or even a reasonable part of it. When a few scientists at one of the international meetings got together and decided that the art of propulsion had come to the point

where we could reasonably ask our Government for support of an extension of our rocket program, to put up a satellite, what I referred to earlier as the long playing rocket, the LPR, to use a somewhat well-known expression, we decided to recommend this because we envisaged such simple things as a solar flare disturbing communication and instead of doing what we have done in the IGY, sending a rocket up and have it turn around and come back and give us one piece of information, we could have the satellite up there during the solar flare, observing it, for the first time giving us the history of a solar flare as it developed and as it subsided. We were naturally excited.

On the other hand, we wanted to be reasonable. We were not concerned with what any other nation was doing. We felt that as one of the great nations capable of doing it we owed it to the period of history and ourselves to do it.

We made the recommendation. The history of it is now quite well known history. It was accepted. The Congress wisely supported us. The military establishments supported us.

In my opinion the program and its scientific concepts has been an eminently successful program in spite of the fact that I have seen no headlines to that effect as yet.

Mr. FELDMAN. I think it has been generally accepted as one of the great achievements

Are there any IGY results to date that emphasize the wisdom of this decision?

Dr. KAPLAN. I am familiar with all of the results that are coming in. The fact that we have gotten up there and the possibility that now exists of extending the solar flare studies is really exciting. In 1 or 2 of our rockets fired during solar flares, by coordination between the solar astronomers and the rocket people, with the astronomers warning them in time so they could get the rocket up, we for the first time understood what kind of radiation from the sun caused ionospheric disturbances and radio blackouts, which are very serious practical problems.

The fact that we will be able to extend this by means of a satellite I have already referred to as really exciting.

Mr. FELDMAN. What continuing role should the academy play in this program?

Dr. KAPLAN. I think the Academy represents perhaps the most objective scientific agency in the Nation. They have no particular interest except to advise the Nation.

There has already been carried out what I thought was a very excellent summer study for the Air Force, they have done some work for the Navy, there are a tremendously increasing number of areas in which they are called on.

I think the Academy is one place where all of American science and thought related to a given technical and scientific field can be focused. This is its role.

It should be there to be called on by the new space agency or by anybody else.

I am sure Dr. Bronk will agree that the future of the Academy will be an increasing use by governmental agencies of the Academy in its advisory capacity, and in terms even of its capacity to operate. But in this case I think advice is essentially what it should give.

Mr. FELDMAN. I have no further questions.

Mr. NATCHER. Dr. Kaplan, we want to thank you for the fine statement you have made to our committee and on behalf of our chairman, Mr. McCormack, and the other members of the committee, I want you to know that we appreciate your appearance.

Dr. KAPLAN. Thank you. It is always a pleasure to appear before a congressional committee.

Mr. NATCHER. Our next witness is Major General Keirn.

Will you come around, please, General Keirn. We are delighted to have you with us at this time.

As I understand, you are the Assistant Deputy Chief of Staff for Nuclear Systems of the United States Air Force, and the Atomic Energy Commission.

General, do you have a prepared statement?

STATEMENT OF MAJ. GEN. D. J. KEIRN,[32] CHIEF, JOINT AEC-USAF OFFICE FOR AIR, NUCLEAR PROPULSION

General KEIRN. I do, Mr. Chairman.

Let me get my titles straight. I am the Assistant Deputy Chief of Staff for Development, Headquarters, United States Air Force. The Deputy Chief of Staff for Development of Nuclear Systems. I am General Putt's assistant for nuclear systems.

In addition I do have a second hat. I am Chief of the Aircraft Reactor Branch in the Division of Reactor Development of the Atomic Energy Commission.

Mr. NATCHER. Fine, General; we are delighted to have you with us. You may proceed according to your wishes.

General KEIRN. Thank you.

I would like to read my statement, Mr. Chairman, if I may.

Mr. NATCHER. You certainly may, General. Go right ahead.

General KEIRN Mr. Chairman and members of the committee, I am happy and honored that this committee has asked me to testify on this most important subject. I am confident that through these congressional hearings will come the legislative actions that will provide the means to insure United States leadership in space and space technology.

Before going into some of the unclassified details of programs for which I have responsibility, I wish to take note that you were given a great deal of information by Gen. D. L. Putt, Deputy Chief of Staff for Development, Headquarters, United States Air Force, on:

1. Reasons why our country should undertake a national space program;
2. Logical agencies to manage and implement our national space program;
3. Space exploration tasks we must emphasize.

[32] Keirn, Donald John, air force officer, b Elbert, Colo, Feb 24, 1905; s John Augustus and Clara May (Rood) K B. S, U S Mil Acad, 1929, M S, in Aero Engring, U. Mich, 1938, student Nat War Coll 1950; m Martha Jean Kennon, Nov. 27, 1936, 1 dau, Margaret (Mrs James Francis Hilleary) Commd, 2d lt USAC, 1929, advanced through grades to maj gen, 1955; AC mem Durand Jet Propulsion Com, 1941, spl assignment jet propulsion, United Kingdom, 1941, chief research br Power Plant Lab, Wright Field, 1942–44, chief Power Plant Lab, 1944–46, liaison officer Manhattan Engring Dist, 1946; project officer nuclear energy for propulsion of aircraft (NEPA), 1946-50; spl asst. to dir div. mil. application AEC, 1947-50, chief aircraft reactors br, 1952——, dep chief staff for research Air Research and Development Command, 1950; comdg. gen 1009th Spl. Weapons Squadron, Washington, 1951, chief Office Aircraft Nuclear Propulsion USAF, 1953-57, asst dep chief of staff for development, Nuclear Systems, 1957——. Decorated Order Brit. Empire, recipient Thurman H Bane award for aero work jet propulsion, 1944. Mem. Inst. Aero. Scis. Presbyn. Home 4255 35th St S, Arlington, Va Office, Nuclear Systems, Hdqrs, USAF, Washington 25.

I, too, believe that we are on the threshold of the space age. Accordingly, we must make aggressive plans and be aggressive in their execution so that we will, at an early date, reap the benefits of space exploration.

As with any bold plans to conquer the unknown, I want to caution that there will be disappointments, even failures. Such failures have not been uncommon during the course of our past ventures into the regimes of supersonic speed and high-altitude research.

Accordingly, while I feel our space exploration program should be bold in concept and plan, it should be deliberate in approach. Our enthusiasm must be tempered with commonsense, and use to the fullest our scientific ingenuity and those elements of our background which have permitted our probing of the outer atmosphere to date.

We must not be subject to decision by emotion. To be really clever requires time.

Our space program and its results must have the respect and admiration of the American people and the peoples of the free world. The guidance of, and the responsibilities delegated by the Congress can insure these objectives.

I feel that our immediate space exploration goals should be confined to the nearest planets of our solar system; Mars and Venus, and, of course, our moon. The mean distances to these near planets are extremely large: To Mars, about 50 million miles; to Venus about 25 million miles; while it is only 240,000 miles to the moon.

I call your attention to the relative nearness of the moon. Assuming straight line travel and an average speed of 25,000 miles per hour, it would require about 83 and 41 days, respectively, to reach these planets, but less than half a day to reach the moon.

If we consider the far planets, Neptune, 2,700 million miles, and Pluto, 3,600 million miles, we find that an average speed of 25,000 miles per hour, the trip would require 12 to 18 years, respectively, 1 way.

This becomes a significant portion of man's life span, and obviously, considerable advances in propulsion must be made before such trips are contemplated.

The partial applications of space flight about which we speak today, such as mapping, weather forecasting, and communications, will, in all probability, be accomplished from orbits in space between the earth and our moon.

To perform these tasks with greatest efficiency, however, will undoubtedly require manned vehicles.

We can gather much basic information by steps that have been taken by the Advanced Research Projects Agency and the Air Force in proceeding with such projects as X-15, the Dynasoar boost glide vehicles, the military satellite mentioned by General Schriever, the recoverable manned satellites, and the space probes about which you have been informed.

In the meantime, the means of propulsion to place man, the equipment to sustain him, and the tools to assist him in space flights, can be developed. The area of propulsion, specifically nuclear propulsion, is one in which I have immediate concern.

Accordingly, I shall confine my remarks to some of the views I hold on this particularly important aspect of any space program.

To reach, navigate, and explore space relatively near the earth, this is, out as far as Mars, I consider three basic propulsion systems must be provided:

First, a boost system to accelerate vehicles from the earth's surface to escape velocity;

Second, an auxiliary propulsion means for navigation, maneuver, et cetera; and

Third, a system for landing, presumably from orbit.

To put it in other terms we may need one propulsion system to start us on the space journey, another to insure we reach our destination, and a third to effect a landing at our destination.

These systems, I think, are separate and distinct technical developments, although it may turn out that a single system may be devised to perform all functions. Unless all are available, exploration of space may turn out to be extremely limited.

Payload has been one of the objectives of flight from the surface of the earth since aviation began. In cargo aircraft, bombers, and ICBM's, we strive to carry the heaviest possible payload.

So it will be again as we attempt to explore space. The sole disturbing feature of the Russian Sputnik II is that it weighs over 1,100 pounds, as compared with the 30 pounds for the largest United States satellite put up to date.

We will always want to place more mass in orbit or on the moon, or near planets, in the form of instruments, cameras, men, and so forth.

Beyond certain payload limits, it will cease to be practical or economical to use chemical boost propulsion and only nuclear propulsion can be considered for the more ambitious large payload missions.

It is interesting to note that with current reactor concepts, which will provide increased performance capability over chemical systems, only a very small faction of the available fission energy is converted to useful work. Because of inefficient use of available energy, the development potential for future nuclear systems is large.

You have probably heard during the course of your hearings comparative statements regarding chemical and nuclear propulsion in connection with rockets. The implication often made is that these systems are competitive.

I am convinced that they will not, in their developed form, be competitive at all, but, rather, complementary systems.

One or the other will be used, depending on the application or the job to be done.

The chemical rocket has not yet been developed to the limit of its performance, and its further development should be supported. The chemical rocket may become the workhorse for boost propulsion analogous to the piston engine in aircraft, and, accordingly, I foresee a continuing requirement for these chemical systems.

The nuclear rocket will be in a class by itself, for use when we wish to reach farther out and carry more payload than can be reasonably accomplished by chemical means.

I can remember well when I brought the first turbojet engine to this country from England, the jibes that were hurled by the piston engine proponents.

"Just a hot breeze in a windstorm," they said. Many of these same people, converted to the attributes of the turbojet and the jet

age, viewed with amusement the efforts of our chemical rocket pioneers until just a few years ago.

I do not wonder, then, that the present proponents of chemical rockets tend to underestimate the future of the nuclear rocket. This is a natural and often healthy aspect of our scientific evolution and progress.

Having devoted most of my career toward effecting progress in propulsion, I have lived through these cyclic advances and fully realize that I do not have to defend the new; new developments defend themselves in much the same way as new products that find their way to the market place in our industrial economy.

The important thing is to recognize the proper time to begin a new development, and once underway, to provide adequate and continuous support. It is not generally known, for instance, that the Air Force considered a nuclear rocket development program in 1946. In this instance, the timing was premature in view of the scarcity of fissionable material and the final application was not sufficiently clear to justify the funds required.

At a more appropriate time, in 1955, this program was reinitiated in the Air Force and, at the request of the Secretary of Defense, appropriate development effort undertaken by the Atomic Energy Commission.

The present program has the support of the Joint Congressional Committee on Atomic Energy and, of course, approval of the Congress.

The initiative and foresight of this decision in the pre-sputnik era was, in itself, imaginative and commendable. Although the resultant nuclear rocket propulsion program, Project Rover, has had a few ups and downs in finding support since that time, it is now, in my opinion, on a firm basis and adequately supported. If this support remains constant, I feel we can provide the nuclear propulsion devices necessary to support future space exploration.

I would now like to touch more specifically on the two programs under my direction in the Joint Office for Air Nuclear Propulsion of the Atomic Energy Commission and the United States Air Force which relate to space technology. The two programs I have reference to are:

1. The nuclear rocket propulsion program, Project Rover.
2. The systems for nuclear auxiliary power program, project SNAP.

You have been given an excellent treatise on the basic propulsion concepts that govern rocket propulsion, and why the nuclear rocket and ion rocket appear attractive by Dr. T. C. Merkle of the University of California Radiation Laboratory at Livermore.

I am sure there is little I could add to those technical details which are a matter of your record.

More recently, Dr. R. E. Schreiber of the Los Alamos Scientific Laboratory discussed certain details of the Rover program. Hence, as you know, the first reactor for the nuclear rocket propulsion program will be ground tested at the Atomic Energy Commission's Nevada test site late this year, and further testing of more advanced devices will follow periodically.

In these later test phases, the Air Force will provide Los Alamos specific support in the development of nonnuclear components under Los Alamos direction.

Under the centralized management of my office, it becomes possible to integrate the unique capabilities of each agency to the best advantage to get the job done expeditiously with the minimum dollar expenditure.

In this regard, the Atomic Energy Commission and the Department of Defense have been working in close harmony. We have kept the National Advisory Committee for Aeronautics abreast of our progress, and have received valuable consultant assistance from that organization.

The step-by-step program planned includes field testing at the Atomic Energy Commission's Nevada test site of devices developed at Los Alamos. Our test site, a 12.2 by 39.6 mile area adjacent to and immediately to the west of the bomb test area, is a spot where the release of radioactive particles can be made in comparative safety.

In addition, the Nevada test site was considered ideal because of the existing support facilities, personnel, and Government-owned wasteland that was available.

The isolation in the case of nuclear rocket testing is more for pro tection of the test personnel in case of accident, rather than concern for the surrounding communities, since contamination anticipated from rocket-engine testing is expected to be negligible.

I have previously referred to three basic propulsion systems, boost systems for earth escape and for landing at destination and a system for navigation and maneuver.

The foregoing remarks apply primarily to our current program to develop those nuclear boost systems that are required to obtain sufficient thrust to lift large payload rockets free of the earth's atmosphere and gravitational field.

Such nuclear systems would also have application in providing the deceleration necessary to effect landings on the moon and for takeoff on return flights—we could, possibly, utilize the atmosphere for partial deceleration on Mars and Venus.

The second system to which I referred, that to provide for navigation, maneuver, or other small perturbations to the basic flight path, might well be a small-thrust, high-specific-impulse, ion-propulsion device.

Let me give you a general idea of the ion-propulsion concept. Tiny, positive-charge ions can be accelerated and directed like the image-producing electrons in a television tube. A stream of these particles, accelerated by means of an appropriate electric field to speeds of many thousands of miles per hour, can produce thrust to the order of a few pounds. We say a few pounds here. We do not know how many pounds, but it depends on the size and complexity of the equipment.

For terra firma applications, this thrust would be ineffectual, but in space, where there is no air resistance and negligible gravity, a small acceleration over a long period of time is sufficient to propel rather heavy interplanetary vehicles through space at eventual speeds of many thousands of miles per hour.

Also, the application of such small thrust for short periods of time could provide necessary vernierlike corrections to the flight path of a space vehicle to correct for errors in navigation and the like.

While a certain amount of research has been completed on ion propulsion under the sponsorship of the Air Force Office of Scientific

Research, the National Advisory Committee for Aeronautics, industry, and other organizations, this propulsion mode is in its infancy as compared to the more powerful and shorter duration boost propulsion systems.

One fact is clear; this type of propulsion system, to be practical, will require large amounts of electric energy.

In my view, then, the success of ion propulsion, in part, lies in the development of reliable, long-lived, lightweight nuclear sources of electric power which are amenable to the space environment. As you know, this environment is demanding, indeed, in that there is negligible gravity and high vacuum.

A device designed to operate in this medium is subject to many, as yet unevaluated, effects such as cosmic ray and meteoric bombardment, which are certain to cause currently unforeseeable engineering difficulties.

An initial use of ion propulsion might be to send a small space probe to orbit Mars for reconnaissance purposes. The optimum manner in which to perform such a trip with an ion-propelled device is to start and finish from orbits about the two planets.

Accordingly, a large-boost rocket would be required to place the ion-propelled device in orbit, since it would not develop sufficient thrust to leave the earth unassisted.

By applying a small acceleration in the space regime of about one ten-thousandth that of gravity over a long period of time, it has been shown for example, that it is theoretically possible to place a 3,000-pound probe in the orbit of Mars in about 300 days. An acceleration of one-thousandth that of gravity would reduce this transit time to about 30 days.

I might add here that the figures I have given you, one ten-thousandth that of gravity and one one-thousandth that of gravity, are the extremes between which we feel it is feasible to build an ion device at this time. It is very dangerous, however, to predict weight until you have built prototype machinery which will give you an idea of what the weights will be. Before such an attempt is made,however, much development work must be done on the development of ion sources and nuclear-power sources.

Let me turn now to program SNAP, or the Systems for Nuclear Auxiliary Power program, which was initiated some 3 years ago, and has been increasingly active in this postsputnik era.

The development of lightweight, long-lived, nuclear-heat sources in the form of reactors and radioisotopes, and the efficient conversion of this heat to useful electric power is the aim of this Atomic Energy Commission program. These would find many uses for space application besides ion-propulsion devices.

As you know, the current small satellites require only a trickle of auxiliary electric power to operate their instrumentation. For example, Vanguard and Explorer need less than 1 watt to power their small transmitters. Sputnik I also is reported to be in the same category.

As our ambitions lead to more and more sophisticated uses for satellites employing television, recording devices, electromagnetic detection devices, more powerful multichannel telemetry, et cetera, electric-power requirements may easily go up to 10 kilowatts or beyond.

Powerwise, a 10-kilowatt electric-power output may be compared to a 12-horsepower outboard motor. Advanced vehicles requiring this magnitude of electric power represent considerable advances over the sputnik-type satellites, but are, certainly, in the foreseeable future.

In addition to a long and reliable life, an obvious requirement for satellite auxiliary powerplants is that they be lightweight since, for every pound of powerplant in orbit we must have—in present 2-stage chemical rocket systems—about 100 pounds of rocket takeoff weight. Future single-stage rocket systems employing nuclear power may reduce this ratio to about 10 for 1.

Fission energy released in nuclear reactors is well suited to the applications under consideration. Very compact reactors can be constructed and a wide range of output power is achievable.

Unlike chemical fuels, the energy content of fissioning U–235 is so large that the amount of nuclear fuel used over a long period represents an insignificant weight.

Again, the old comparison that 1 pound of U–235 is equivalent to about 2 million to 10 million pounds of chemical fuel serves as a useful comparative guide. On this basis, the 10-kilowatt electric unit would use only a very small amount of nuclear fuel in 1 year's operation.

Various methods can be employed to convert the reactor's heat output to useful electric energy. Thermionic emission, and thermoelectric devices, have the advantage of no moving parts, but are farther from practical utilization than conventional thermal-power cycles which use turbines and generators.

All have a common problem; that is, the employment of a high-temperature radiator to dissipate waste heat by radiation only to outer space. The ordinary means of cooling by the circulation of air is impossible, due to the high vacuum environment; therefore, the radiator must be operated at relatively high temperatures to dissipate heat efficiently by radiation to keep its weight down. The design of this radiator must be sufficiently sturdy to tolerate possible meteorite damage.

Many new methods are also of use in conjunction with another form of nuclear energy, radioisotopes. By 1975, it is estimated that the nuclear-power industry will have produced over 50,000 kilowatts decay energy in radioactive waste or radioisotopes. These radioisotopes can create heat when emitted alpha or beta particles are stopped and lose their energy in suitable materials.

It is also worthy of note that certain reactor-produced transplutonium elements, such as californium 254, decay by spontaneous fission and offer amounts of power up to 6,000 heat horsepower per pound.

Obviously, many factors must be balanced in using radioisotopes. The power requirements, sensitivity to radiation of the payload components, shelf life, and expected lifetime of the satellite or space vehicle must be weighed against the isotope's characteristic radiation, its half life, and the AEC's ability actually to produce it in quantity, according to schedule, and at a reasonable cost.

In obtainable form, the radioisotope cerium 144, for example, produces 4.5 horsepower per pound. With purification, this could be increased to almost 15 horsepower per pound—this is heat horsepower.

This isotope's power output decreases by a factor of one-half every 290 days, its half life. Thus, by including an excess amount of the

isotope initially, we could design a unit with a few years' life for a specified power level.

Other radioactive-waste isotopes, such as strontium 90, decay with longer half lives—28 years—but are somewhat lower in specific power.

As some of you may recall, gasoline was onetime a waste product of oil production. Cerium and strontium are both waste products in the production of nuclear power.

The price of isotopes produced by the Commission is determined by the cost of production. The cost per unit of radioactivity reduces greatly with increased production. Present demand, which is mostly civilian, is low, and prices are much higher than they would be if there were large-scale demands. Initially, the large demand will come from the military. However, we hope that many civilian uses will be developed from this program.

In contrast to nuclear-fission energy and radioisotope-decay energy, chemical fuels and the sun have both been considered as power sources for satellites, and the sun has been proposed to furnish power for satellites and space vehicles.

The attractiveness of the sun results from the fact that its radiation is a relatively constant reservoir of energy in free space, producing about 130 watts per square foot. Conversion of this energy to electricity can be accomplished directly with solar cells or by using a heat collector and employing a conventional heat cycle as with nuclear heat sources

A solar unit with a 10-kilowatt electric output using either photoelectric cells or a solar heat collector in conjunction with a thermal-power cycle, would need an area of about 2,000 square feet, and would weigh on the order of 8,000 pounds. Conventional heat cycles, using nuclear units, could accomplish this job with a 300-square-foot radiator.

Chemical auxiliary power units are relatively off-the-shelf items. Many military aircraft are equipped with small gasoline-fueled engines to provide several horsepower.

Assuming that we could use a gasoline-fueled unit, and neglecting the weight of the unit itself, a 10-kilowatt electric-power unit for an earth satellite operating only 30 days would require about 15 tons of fuel plus oxygen Obviously, if we expect to furnish modest power levels for reasonable lifetimes for very expensive satellites, we must use something else. Batteries are not much better, as they are a special form of chemical power and weigh even more.

The inadequacies of both solar and chemical sources of energy are apparent. The solar source has some advantages in the very small sizes, but is not competitive in the kilowatt range with the nuclear sources of energy, radioisotopes and fission reactors.

Actually, solar energy does not appear to be competitive above about 10 watts. The low weight per unit power of nuclear-energy sources makes up for the additional weight involved in nuclear shielding.

The foregoing briefly denotes why I believe that our space future will draw heavily on nuclear energy and the reasons we in the Office for Air Nuclear Propulsion are so intent on its development.

This completes my prepared statement.

I shall be very happy to assist in any way I can, and to answer questions

Mr. NATCHER (presiding). General Keirn, our chairman introduced a bill: H. R. 11881, which provides for research into problems of flight within and outside the earth's atmosphere and, generally, sets up and creates the NASA. This bill, as you know, General, incorporates the proposals made by President Eisenhower. Under this bill, we have a civilian-controlled space agency. Do you agree, General, that it should be a civilian-controlled group?

General KEIRN. Yes; it is my personal belief that it should be.

Mr. NATCHER. The bill provides, further, that there is to be a director. In your opinion, General, should the Director be a scientist, or should he be a successful businessman, well qualified as far as administrative ability is concerned, or what type of individual do you think he should be?

General KEIRN. It is very difficult for me to put a tag on an individual in terms of whether he is a businessman, scientist, or engineer. I think, actually, he has to have some of the qualifications of all three. Certainly, he has to be a man of some stature in the scientific community. He must be a man who understands scientific facts. He must be a man who can sift in his own mind some of the very complex problems that are essentially scientific in nature.

On the other hand, I think one must beware of a scientist who has devoted all his attention to a limited area. He may be an expert in this area, but he may not have the judgment required in other areas.

So for this reason, while I say this man should have a lot of characteristics and qualifications of a scientist, I think he should also be an engineer. I think he should be able to apply scientific knowledge in an engineering sense and be able to make decisions with regard to when a theoretical proposal is ready to move toward a hardware phase.

Then, of course, he has to be a good administrator because he cannot manage an agency of this size unless he knows how to administer, knows people, knows Government routine, and has a full understanding of these problems.

You have to find someone who has some of these qualifications in all three areas.

Mr. NATCHER. General, the bill further provides for a Space Board not to exceed 17 members, not more than 8 of the members are to be drawn from Government agencies and departments and at least 1 of the members of the Space Board is to be designated by the Department of Defense.

In your opinion, should all the military services be recognized on this Board and be represented, 1 from the Army, 1 from the Navy, and 1 from the Air Force? It says at least one member from the Department of Defense.

In your opinion, should there be more than one member?

General KEIRN. In my opinion the answer is "Yes." I could elaborate on that a little bit. I think I am aware of the desire on the part of the authors of the bill to provide for flexibility so that they would not be tied down and they would have to come back to Congress every time they wanted to change membership.

On the other hand, I think it is important that all of the areas of skill which fit into this space age have some kind of representation on this Board.

The Army, the Navy, and the Air Force are all interested and have major areas under their cognizance. I think they should have repre-

sentation. I would include, also, the Atomic Energy Commission.

Mr. NATCHER. I did not quite catch your last statement.

General KEIRN. I would include, also, the Atomic Energy Commission.

Mr. NATCHER. General, this bill, as you know, when enacted or some similar bill, will take the place of the NACA. This will be an operating agency, not an advisory agency.

Do you have any suggestions to make to the committee at this time concerning any provisions that should be in this bill or do you have any suggestions at all that would be of benefit to the committee from the standpoint of this particular type of legislation?

General KEIRN. I have studied the bill to some extent and discussed it with others. I have known the NACA for many, many years. I have worked very closely with them since 1938. The bill, as I read it, would create an organization which would function presumably in very much the same way as the NACA has functioned.

I think this has been very, very satisfactory. I think this has been one of the outstanding agencies as far as the scope of work and the ability to coordinate their efforts with other Government agencies.

I would not like to see this pattern disrupted. Now, aside from that, it is difficult for me from reading the bill, to know just how it would be implemented, to know whether this pattern would be followed or not.

I can only say in my opinion we should not try to disrupt the pattern of operation which I think has been very successful.

Mr. NATCHER. Mr. Feldman.

Mr. FELDMAN. General, you say the Agency has functioned very well, and we also hear that the military has functioned very well in this field. Then why is it that the Russians are ahead of us in this field?

General KEIRN. I suppose the proper answer is that we have not functioned well enough.

Mr. FELDMAN. Then do you not think we ought to get a new Agency that can function well enough and will get the cobwebs out of our system and do something?

We heard from General Gavin, we have heard from Admiral Rickover and from others, that this is a life and death struggle and yet at the same time we treat this thing as just another passing fancy. Do you not think we ought to do something about it?

General KEIRN. I certainly think we ought to do something about it. I am not sure that it is in this specific organization that we will find the answer or the reasons why we are behind the Soviets at the present time.

Mr. FELDMAN. Would you repeat that again?

General KEIRN. I feel personally that the answer as to why we are behind the Soviets is not wrapped up entirely in a question of organization. I think there are many facets.

Mr. FELDMAN. For example?

General KEIRN. Our whole national attitude I think is poor.

Mr. FELDMAN. Precisely. We are told that this is a great Agency; the NACA did a great job. We are told that the military has done a great job. You, in your statement, say that in 1946, such a program was suggested by the Air Force for the development of nuclear rocket propulsion.

General KEIRN. It was considered.

Mr. FELDMAN. It was not until 1955 that we got started. We know in between time it was discussed many times. We know it was vetoed by some of the people, by the former Secretary of Defense. That is an open secret.

Now, if we are going to get off the ground, do you not think that we ought to really clear the path completely and start in a new way to see that we are not hamstrung by past thinking?

General KEIRN. This is very difficult for me to answer, Mr. Feldman. I think we will lose time initially if we so disrupt our present organizational procedures and at least initially we would be a little slow in getting going.

Mr. FELDMAN. I am not toying with the idea or in any way attempting to interfere with present organization procedures except to this extent: I know that the military themselves recognize it because we know of the record that came down in connection with general duties and we know what you are doing, for example in this field.

But I do think that we have a clear line of demarcation in the record between some pretty dedicated people like General Gavin, as I mentioned before, and Admiral Rickover and Admiral Hayward.

On the other hand, they have the placid attitude on the part of others who say let us relegate this new Agency, just let us get started, let us extend the NACA a little more and in that way try to develop a program. That is not going to do it.

Do you not believe that we have to change our whole attitude?

General KEIRN. I am sure we have to change our attitude.

Mr. FELDMAN. And we have to go full speed ahead and not let anything stand in the way of this program because it is a very potent one. Do you recognize that?

General KEIRN. Yes, I do. I agree with your sentiments on that.

Mr. FELDMAN. Do you think that Dr. Dornberger was wrong yesterday when he testified to the fact that this is a life-and-death struggle?

General KEIRN. I did not hear his testimony.

Mr. FELDMAN. I can say that he did testify along those lines yesterday. In fact he used those words.

General KEIRN. I think it is most important to the future of our Nation to move expeditiously in the direction which this committee is deliberating on.

Mr. FELDMAN. Do you not think that the new Agency should be on the kind of level that is at least near the Cabinet level. Should not the new head of this Agency, for example, be a member of the Security Council?

General KEIRN. He is, I believe, appointed by the President.

Mr. FELDMAN. Yes; and confirmed by the Senate.

General KEIRN. Really I have not given it this much thought. I have no opinion whether he should be a member of the National Security Council or member of the Cabinet.

I can say it is my opinion he should be given a high post. He should be given a position of stature in our Government where he can say something.

Mr. FELDMAN. Is your program being supported completely, to the fullest extent that you think it is necessary?

General KEIRN. As a protagonist for nuclear propulsion, I can only tell you that I could use some more money.

Mr. FELDMAN. Are you satisfied that you have the people that can accomplish the job if you do have the money?

General KEIRN. I am satisfied that we have competent people doing the job.

Mr. FELDMAN. It has been said here that if we are to have a million-pound-thrust engine that it will have to be nuclear propelled. Would you agree with that conclusion?

General KEIRN. No; I think not. I think we can build a million-pound chemical engine. I did not mean to give the inference that you would have to use nuclear power to have a million-pound-thrust engine. I believe you can build a million-pound chemical engine. I believe, however, that a million-pound chemical engine would not get you as far into space as a million-pound-thrust nuclear engine.

Mr. FELDMAN. Why?

General KEIRN. Because of the specific impulse of the chemical system which is materially less than what we expect to get from the nuclear system.

Mr FELDMAN. Have you any connection with the military liaison between the Atomic Energy Commission and the Department of Defense?

General KEIRN. Yes, sir. I have never been a member of this military liaison committee but many of the relations between the Atomic Energy Commission and the Department of Defense are handled through the military liaison committee, so I am quite familiar with their method of operation.

Mr. FELDMAN. Is it a constant and continuous liaison?

General KEIRN. I would say "Yes" They have staff members that make it their business to follow certain lines of endeavor and keep in touch with them.

Mr. FELDMAN. Do you find their activities useful?

General KEIRN. Yes. I think that once an agreed upon relationship between the Commission and the Department of Defense has been established, and it is through the military liaison committee that such relationships are established, then there is the direct communication between the Department of Defense and Atomic Energy Commission

Mr. FELDMAN. Is there any delay caused by the establishment of that contact through the military liaison?

General KEIRN. There is the delay that is natural to discussions with a liaison group. I cannot say that there has been a kind of delay that has really affected the program.

Mr. FELDMAN. Would you say it has aided it?

General KEIRN. Yes.

Mr. FELDMAN. Under the new proposal the Board is advisory in nature and is required to meet no less than four times a year. The old NACA Board, which is the executive authority group on top which runs the present NACA, has been meeting, according to General Doolittle, Chairman of the Board, about 10 times a year.

The new Board, which would be the executive authority, would probably meet, say, 10 times a year also. Its function would be advisory and it is not created for the purpose of establishing liaison between NACA and any other agency, even though it is required to have at least one member of the military on the Board.

Do you feel that a liaison arrangement corresponding to one between the military and the AEC, of a general nature, should be established or set forth in some way in the new law for the purpose of insuring a continuous flow of information between the NACA and the Department?

General KEIRN. Let me say that in the past there have been established committees which have served this purpose between the NACA and the military departments and industry. I think these committees have served a very useful purpose and really have handled the kind of thing which you seem to have in mind. So I am not really of the firm opinion whether one should be so established by law or whether they can be set up as committees in a fashion similar to the ones we have had in the past.

Mr. FELDMAN. Dr. Dryden told us that the number of members on various committees is over 500.

General KEIRN. I believe it is very large, but they are not on one committee. They occupy key positions in Government, in industry, or with the NACA and they meet at frequent intervals to coordinate their activities in particular areas.

Mr. FELDMAN. For an agency engaged primarily in a research function, I can see where they might have a lot of committee members, but if you are going to get an agency that is going to try to accomplish something, build hardware, do things, when you have a number of committees in which the membership is over 500, are they not likely to "committee' things to death?

General KEIRN. I think these 500 are not on one committee, as you know.

Mr. FELDMAN. There are committees and subcommittees and so on, layers and layers and layers of committees.

General KEIRN. There are two kinds of committees. There are the committees who are appointed to review our programs at the governmental level, on an ad hoc basis. The committees I am referring to are committees of operating people who coordinate their respective activities to be sure that the efforts of the NACA, the efforts of industry, the efforts of the military services are all tied together.

This kind of committee is very useful. It is done in those cases where there is need for a coordination between the two independent agencies. General Schriever, I believe, has a committee on certain aspects of his program which ties in with his work. Committees of that nature are essential and are useful.

Mr. FELDMAN. Could you not cut out all these committees by simply having a liaison established by law?

General KEIRN. It is my opinion that you could not, because there are so many areas that require the individual competence of individual people on a particular committee. You cannot man a liaison committee with such people of sufficient stature. These people on the working committees I refer to are employed in laboratories, they are doing work, conducting their part of the work. Then they meet to see that they are coordinated with the work that other people are doing. I do not think you can get around that kind of committee.

Mr. FELDMAN. By establishment of the Atomic Energy Commission Act, that liaison is not only functioning on top but also in the manner you speak of, down to the very project itself.

General KEIRN. I believe we have committees outside of the liaison committee working.

Mr. FELDMAN. Precisely. Now I am exactly right where I started from. In other words, we began by having you tell us that the liaison committee, the military liaison committee between the AEC and the military is functioning very well. Then I am told that it is not really necessary. So I am in a kind of quandary at the moment. I guess it is because of the fact that maybe the NACA does not like to have anything new added into the law and for that reason many who have testified in connection with the law feel they should not have it in because the NACA does not want it in.

General KEIRN. This is not my reason in questioning it. I believe I have said I have not really resolved my thinking on this particular point. I do believe that the working committee arrangements as they have existed between NACA and the services have been useful. As to the purpose of a committee set up legally and by law, I think I have not analyzed the problem enough to really give you an answer.

The relationship of working between NACA and the services has been ideal.

Mr. FELDMAN. Do you feel that an extended or even a greatly extended NACA will accomplish the task of having us catch up with the Russians or, more than that, leapfrog them which is what General Gavin said we need to do?

General KEIRN. I believe we will do so provided there is a continuing effort on the part of Congress to see that we are provided with tools and funds that are necessary to do it.

Mr. FELDMAN. Do you not think it will be done by the men who head it and people who head it so that you can show Congress? Do you think, for example, if you had a corresponding situation like the one you ran into in 1946 where you had a program and then it was abandoned, that that would accomplish this purpose?

What I am trying to say is simply this: Instead of throwing the ball back to Congress and saying, "Give us money, press a button and make this thing work," it is going to take somebody on top who knows what he is doing and can do the job and who has the imagination and the guts, if you will, to push away all the obstacles that will confront him and get the thing done?

General KEIRN. I am surely in agreement with that, Mr. Feldman.

Mr. FELDMAN. So that it is not Congress that is going to be the one upon whose shoulders rests the accomplishment of this job, but it will be the person who is on top of this Agency; is that not so?

General KEIRN. Yes; you surely have to have the assistance of Congress when the budget comes up.

Mr. FELDMAN. And Congress can write the strongest bill in the world and if the person administering it does not do a good job, the purpose will not be accomplished.

General KEIRN. I agree with that 100 percent.

Mr. FELDMAN. So that what we need is the strongest kind of person to head this new Agency; is that not so?

General KEIRN. Yes; I think I can agree with that.

Mr. FELDMAN. He ought to be almost a superman.

General KEIRN. He will have to have unusual ability.

Mr. FELDMAN. More than unusual—great ability and respect; is that right?

General KEIRN. Yes.

Mr. FELDMAN. Do you feel that the nuclear-powered aircraft is competitive with or complementary to Project Rover? What priorities would you assign to each?

General KEIRN. First of all I consider them complementary. The manned airplane program, I believe, is the one you are referring to. I believe they are complementary. I believe they should have equal priority. I believe that Rover is fundamental to our long-range national well-being. I think the manned airplane program is a fundamental approach to a shorter range program and that is to retain deterrent power over Russia.

Mr. FELDMAN. The 1946 nuclear rocket propulsion system was in addition to the NEPA studies by Fairchild, or were these one and the same thing?

General KEIRN. I believe that NEPA probably looked at nuclear rockets. One of our first proposals, however, for nuclear rockets in 1946 came from the west coast. This was a specific application of nuclear power for rocket propulsion. This was the first presentation.

Mr. FELDMAN. Do you feel that thermionic and solar energy converters will eliminate such conventional power sources as steam and intercombustion engines.

General KEIRN. You say thermionic and I suppose you are also referring to the devices like thermocouples and the advances in that state of the art. It appears there have been some breakthroughs in that in the last year or two and it would appear that efficiencies now comparable to those you achieve from a terminal cycle may be possible.

Theoretically, they seem to be possible. We just do not know how to do it yet.

Mr. FELDMAN. You indicated that Sputnik 2 was over 1,100 pounds. What about the rumors that the sputnik actually weighed over 5,000 pounds?

I have heard that it weighed as much as 3,000 and I have heard 5,000 also. Do you have any information on that?

General KEIRN. I do not, Mr. Feldman. I think I have heard that rumor but I have no information on it to know whether there is any foundation for it.

Mr. FELDMAN. I have no further questions.

Mr. NATCHER. Mr. McDonough.

Mr. McDONOUGH. General Keirn, I think your statement is an excellent one. I think we can gain a great deal from your testimony. The 2 projects that you refer to, Dynasoar and Rover, in what position of implementation are these 2 projects? How close to possible implementation?

General KEIRN. I can speak for Rover. Rover is in the development state and we will have a nuclear reactor on test at the Nevada test site in the fall. Now, on the Dynasoar project, that is not a project for which I have responsibility and I cannot really tell you whether it is in hardware or merely in the study state. I do not know.

It has been studied quite extensively. I cannot tell you whether it has gotten into any kind of hardware stage or not. The X–15, of course, is a step in that direction.

Mr. McDONOUGH. In other words, Rover is a nuclear-powered vehicle?

General KEIRN. It is not a vehicle, just the machine for producing the thrust. So we might apply Rover to a device like Dynasoar. We have no plans to do that, but it could be so applied. Rover specifically is an effort to build a propulsion machine.

Mr. McDONOUGH. You may have answered this question about whether we should set up a commission form or an agency. Which of the two do you think will give us the quickest action and the greatest progress.

The Agency would have a board of 17 and a director and the Commission would have 5.

General KEIRN. I have read the bill. I have known the National Advisory Committee for Aeronautics for many, many years. I have worked very closely with them. I lean very much toward an organization which functions in a manner somewhat similar to the NACA. Whether or not there should be a 17-man committee or a commission, I have the feeling there should be a committee of rather wide competence.

I think in this respect I lean toward the board of 17.

Mr McDONOUGH. You are the liaison officer for the Air Force in the Atomic Energy Commission?

General KEIRN No, I have a specific position with the Atomic Energy Commission. I am Chief of the Aircraft Reactor Branch in the Reactor Development Division of the Atomic Energy Commission.

Mr. McDONOUGH. But your military assignment is with the Air Force

General KEIRN. My military assignment is as Deputy Chief of Staff for Development, Nuclear Systems, Headquarters of the Air Force

Mr. McDONOUGH. In your opinion, are we progressing as rapidly as we can both in the industrial potential and in the basic research that we are doing now, or should we need a stimulating program or crash program to move faster?

General KEIRN. I think we are making good progress in both research and in the actual development, particularly in the program with which I am associated. I cannot be truthful without saying that we can use some more funds.

Mr McDONOUGH. In the research field?

General KEIRN. It can be divided. We are pushing basic research about as hard as we have people of competence to do it. In the particular programs I am associated with there is a great deal of basic research that is setting out timetable so to speak; the development of high-temperature materials, this is one of our major problems. We have everyone on it we can find who is competent to do it. We are putting every effort on it and we are not hampered by lack of funds in this particular area.

Mr. McDONOUGH. We need to speed up our program on the development of energy propulsion elements, solid or liquid fuels. Are we moving as fast as we can in those directions?

General KEIRN. I have no responsibility in the chemical propulsion field. I cannot speak on that. I think General Schriever may have already spoken on that. From my discussions with General Schriever he is making good progress but he thinks perhaps he can make a little more.

Mr. McDONOUGH. Thank you very much.

Mr. NATCHER. General Keirn, on behalf of our chairman, Mr. McCormack, and other members of the committee, I want to thank you for the fine statement you have made this morning and for your appearance before our committee.

Thank you very much.

General KEIRN. Thank you, Mr. Natcher.

Mr. NATCHER. The committee will stand adjourned until Monday at 10 o'clock.

(Whereupon, at 12:40 p. m., the committee recessed to reconvene at 10 a. m., Monday, May 5, 1958.)

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ASTRONAUTICS AND SPACE EXPLORATION

MONDAY, MAY 5, 1958

House of Representatives,
Select Committee on Astronautics
and Space Exploration,
Washington, D. C.

The committee met at 10:10 a. m., pursuant to recess, in the caucus room, Old House Office Building, Hon. John W. McCormack (chairman) presiding.

Present: Representatives McCormack, Metcalf, Natcher, Sisk, Fulton, Keating, and Ford.

Present also: George J. Feldman, director and chief counsel.

The Chairman. The committee will be in order.

The first witness is Hon. Roy W. Johnson, Director of the Advanced Research Projects Agency of the Department of Defense.

We are very glad to have you with us, Mr. Director. I note you have a prepared statement. We will be very glad to hear from you.

STATEMENT OF ROY W. JOHNSON, DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY; ACCOMPANIED BY REAR ADM. JOHN E. CLARK, DEPUTY DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY, DEPARTMENT OF DEFENSE

Mr. Johnson. Thank you, Mr. Chairman.

Mr. Chairman and members of the committee; it is a pleasure for me to appear before your committee to discuss the Advanced Research Projects Agency activities and its organizational relationship with other agencies. I believe that ARPA's organizational relationship with other agencies is of the most interest to the committee so I will address my remarks primarily on that aspect.

Since ARPA was organized on February 7, 1958, we have spent considerable time working with other DOD staffs on our assigned projects. Our frame of reference has been the directive from the Secretary of Defense which gives to ARPA the responsibility for planning and directing advanced research projects involving space science and technology, ballistic missile defense, and other advanced research and development as assigned by the Secretary.

The projects which have been assigned mainly required coordination with the Director of Guided Missiles because existing vehicles, components, and facilities must be utilized. This method of operation is a precedent which will set the pattern for future ARPA projects.

In other words, it is not the intent to expand to a large organization that will require extensive laboratories and other facilities. Undoubtedly, however, there will be some modification of existing facility

complexes in order to keep from impairing effort which must be applied to weapons systems. I feel the important point is that existing organizations can be utilized. This approach not only saves valuable time but also costs much less money.

The Assistant Secretary of Defense for Research and Engineering is the staff adviser to the Secretary of Defense on all military research, development, and engineering matters. He will be informed on the activities which have been assigned to ARPA, and he will utilize the ARPA staff for technical and administrative reviews to the extent necessary to fulfill his requirements.

Another way of explaining our actions is that we have and will be assigned specific projects which we will manage and provide funds for implementation. This method of operation is the key to the important objective to be served by ARPA.

For instance, we will have the scientific capability to review, direct, and expedite research programs which in the past have been retarded because of the requirement that they be based on a military weapons system. The scientific capability referred to will be provided mostly by a contract with the Institute for Defense Analyses with a staff of about 25 scientists. However, many of the staff are also members of other committees, such as Dr. York's membership on Dr. Killian's committee. In this manner we will have access to the best scientific talent in the United States to assist in the acceleration of the national technological status.

In addition, such projects as the ICBM defense may become so large in the future that it would be advisable to consider a management-type contract in order to provide a means for tying together the many diverse developments required for the overall defensive system.

Our method of operation in the Department of Defense is to deal directly with the service agency that has the capability to accomplish our projects. This naturally bypasses many established channels but has the decided advantage of saving valuable time and money.

We realize that service agencies are already performing important missions. However, they are in the best position to state if our projects can be accomplished without disrupting other directed projects If our projects can be undertaken, then ARPA will write funding orders direct to the operating agency. We have already begun to function in this manner.

Some examples are the lunar probes, and the escape guidance experiment and associated ground equipment. The Army, Navy, and Air Force all will participate in these experiments.

Of course, in addition to the service participation, ARPA coordinates with other agencies outside the DOD such as the National Advisory Committee for Aeronautics, the National Academy of Science and the National Science Foundation.

The President has authorized ARPA to proceed with the projects I have just mentioned for a period of 1 year. In furtherance of his proposal for a National Aeronautic and Space Agency, he has directed that these projects be reviewed for responsibility. We have begun preliminary discussions with the NACA on this subject.

Last week the ARPA presented its fiscal year 1959 fund request to the Subcommittee on Department of Defense of the House Appropriations Committee. Of the $520 million requested, we have pro-

posed that $448 million will be utilized for military purposes associated with missile defense, military satellites, and space technology in the fields of propulsion, instrumentation, data handling and reentry phenomena. Seventy two million dollars was requested to continue the nonmilitary space projects of the type which have been authorized by the President. All of the funds requested represent our best judgment on what we can accomplish when all factors are considered, including the present status of technology.

On this planning basis, our overall objective is to expedite those projects which are of immediate national importance and interest, and at the same time to project ourselves into the future as far as possible on other type research.

Dr. York has discussed with the committee the general problem of dividing space research between the Department of Defense and the proposed NASA. I believe a civilian astronautics agency should be created with its own funds for use in pursuing its programs. However, military programs already demand the use of outer space for many uses for the protection of our country.

The legislation setting up a civilian group should not be so worded that it may be construed to mean that the military uses of space are to be limited by a civilian agency. This could be disastrous. It behooves the writers of this legislation to state positively this freedom clearly and without equivocation.

For example, if the DOD decides it to be militarily desirable to program for putting man into space, it should not have to justify this activity to this civilian agency.

We are at a point today where the world stood centuries ago when Columbus sailed westward, but we are much better prepared with the technical knowledge for exploration than was Columbus. The exploration of our atmosphere and the stellar system offers tremendous challenges and opportunities. If we plan now, we can approach the new era confidently and hopefully. To this end I believe that long-range planning should be undertaken immediately by a group composed of representatives of the NSF, NAS, NASA, ARPA, and others as deemed appropriate, under the guidance and overall direction of the President's Scientific Advisory Committee.

Regardless of who has the responsibility for these projects, considerable cooperation must exist in order to accomplish them. Insofar as possible, I believe that existing facilities and personnel must be utilized. Considerable scientific talent is available in the United States for the exploration of space and other advanced research. However, proper direction must be exercised to obtain the maximum benefit. ARPA is prepared to support fully any decision that is made in regard to a civilian controlled space agency.

I believe that substantial benefits will accrue from a well-planned and coordinated effort. This can and will be a fast-moving business, but the objective will be not only to advance our technological status but as an end product to maintain our national security.

I have with me Admiral Clark, Deputy Director, and we are both prepared to answer questions.

The CHAIRMAN. Do you have a statement, Admiral?

Admiral CLARK. No, sir.

The CHAIRMAN. I think it is very good to have you both here so that members can ask questions of either one of you, and you can

elaborate and make it sort of a panel. I like the results of that type of an atmosphere.

Mr. Johnson, you said, "I feel the important point is that existing organizations can be utilized."

That means, as you later indicate, that where there are conflicts or something might fall within what might be termed a gray area, somebody has to make decisions. Is that right?

Mr. JOHNSON. Yes, sir.

The CHAIRMAN. In your opinion, who would be the one to make that decision?

Mr. JOHNSON. I think, the way the legislation is contemplated now, it would have to be the President's Office.

The CHAIRMAN. Where in the bill would be the language to that effect?

Mr. JOHNSON. I infer, from the fact that the civilian Space Agency director will report to the President, or act in a reporting capacity to the President, this conflict will go to his office.

The CHAIRMAN. I will cover that a little later.

You have also stated, of course, as we know, on the civilian aspects ARPA was set up for a year——

Mr. JOHNSON. Yes, sir.

The CHAIRMAN (continuing). Which I think was a very wise thing to do. So somewhere in the Government we would have progress being made.

We all recognize and realize the importance of the military aspects. You do not have to argue that with members of this committee. The question is the kind of language that will accomplish the results desired both from a civilian angle and the military angle.

We all recognize, and you do not have to argue much, that much good has come to mankind on what might be called the civil side that has grown from military activity, not only now but for many years gone by. Yellow fever and many things can be cited where mankind has been benefited. So those things are understood, or should be understood, by legislators, and I know on this committee they are.

You say the President has directed these projects be reviewed for responsibility. Are you in a position now to give the committee more information as to how far the review has gone?

Mr. JOHNSON. Yes, sir, Mr. Chairman. I think I can give you this from memory. We have been in session for several weeks with Dr. Dryden's group.

The CHAIRMAN. With whom?

Mr. JOHNSON. Dr. Dryden of the NACA. At the moment I think we are in agreement concerning the lunar probes and the other satellites that were authorized by the President some 4 or 5 weeks ago. They would all be transferred after the calendar year, those not completed after the calendar year 1958, to NACA.

In addition, we are asking for approximately—is this classified, Admiral?

The CHAIRMAN. Do not give any classified information. If we want it we can get it in executive session.

Mr. JOHNSON. I can put it this way: We are asking for additional projects that will be shared by Dr. Dryden's group and ARPA. So that roughly $95 million——

The CHAIRMAN. $95 million?

Mr. JOHNSON. $95 million of ARPA's budget as now submitted to the Appropriations Committee, and if adopted by the Congress, would be transferred to NACA; $72 million of this would be purely scientific, and the other $23 million would be work shared that would be partly military and partly civilian.

The CHAIRMAN. For the record, will you explain what is meant in the appropriations by lunar projects?

Mr. JOHNSON. The lunar probes are orders on the Army for an attempt to launch satellites around the moon that would have equipment in them to take a very crude picture of the back side of the moon. We have placed a similar order on the Air Force to make a similar attempt using a different missile. We hope that both will be successful and will add to our knowledge of the atmosphere, or the air around the moon. We certainly will know more about the air around it and perhaps get a picture of the back side.

The CHAIRMAN. In your statement you also have broken down the $520 million you have requested, and you mention reentry phenomena. Can you give us any idea as to what the position of the Soviet is in connection with the reentry phenomena?

Mr. JOHNSON. It is a personal opinion, and I think there is some verification for it, that they have conducted experiments with reentry missiles. The hope was, I believe, when they put up sputnik with the dog in it they would return it safely. That is the supposition at least I have heard expressed by many people who have studied this matter.

We have money appropriated or will have money appropriated, we hope, to continue experiments in reentry phenomena in 1959, and I think we will accomplish this successfully. The problem is not as tough as people presumed it to be a year ago.

The CHAIRMAN. I can understand that.

Coming to the bill—I do not want to ask too many questions because I like to have the members of the committee participate as soon as possible—on page 2 of the bill, Mr. Johnson and Admiral, line 7, the previous lines create a civilian agency as provided in the bill, and then this says:

except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations.

Will you define what those words mean, to what extent that would give jurisdiction to the Defense Department to make final decision? Because under this language the Defense Department makes a finding of anything that is peculiar to or primarily associated with weapons systems or military operations; as I read the language, the new Space Agency would not have any voice.

Mr. JOHNSON. I believe that it might be construed that way; I think this language also could be subject to a different sort of interpretation. I think it might be interpreted that the military could not proceed on its own without participation of the civilian agency.

The CHAIRMAN. We all recognize, as I said, the importance of the military in the world of today and the foreseeable future. Under the language of the bill I can see where there would be a clash which all understanding minds should want to avert. We have to project our minds into the future and sort of see what might arise after we have completed the job on the legislative level and then it gets into the field of administration.

Of course, that can be met; I can see that. I just wanted to get your views, because it could be under this language where just men who are stubbornminded—you will find them everywhere, good men, but oftentimes men with hard views, stubborn views—who might say this gives the Defense Department complete authority as to procedure as to activities that may be peculiar to or primarily associated with weapons systems or military operations. They might say that covers everything. So it would be creating a civilian agency, but in name only.

Do you see the possibilities of that language there?

Mr. JOHNSON. I read the language just the other way. The way I read it would mean that things that are peculiar to or primarily associated with weapons systems of military operations shall be done in cooperation with, or on behalf of, the Department of Defense by the civilian agency.

The CHAIRMAN. Will you define, then—you cannot do it in every particular, but I think the record ought to show it—what is meant by that language?

Mr. JOHNSON. I have written some, what I think is, clarifying language to this point, which I would be glad to read.

The CHAIRMAN. We would be very glad to receive it.

Mr. JOHNSON. I could read this.

The CHAIRMAN. I think it would be well to read it into the record.

Mr. JOHNSON. This is the way I would like to recommend that the language read:

> The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States, except insofar as such activities may be—

then I struck out "peculiar to or primarily associated with weapons systems or military operations" and substituted "in support of or presumed to lead to the use of space for national defense, in which case the Agency"—and I struck out "may"—

> is authorized to act in cooperation with, or on behalf of, the Department of Defense is so requested by the Department of Defense.

The CHAIRMAN. Is that the viewpoint of the Department of Defense?

Mr. JOHNSON. No, sir; this is the viewpoint—well, it is the viewpoint of myself as Director of the Advanced Research Projects Agency. I have not discussed this within the Department of Defense outside of people associated with me in this Agency.

The CHAIRMAN. What would you mean by the word "presumed"? I understand what it ordinarily means, but it could be capable of different interpretations under different circumstances.

Mr. JOHNSON. I think it is advisable to have very broad language, and I have selected this word "presumed" because it is quite broad. I think there must be an interpretation here that would lead to exploration in military science without necessarily a specific military weapons system in mind. I believe it is very important for the Department of Defense to be permitted to explore military science ahead of actual need for that knowledge for weapons systems.

The CHAIRMAN. "In support of or presumed to lead to the use of space for national defense" is broader than the words "peculiar to or primarily associated with"—and I emphasize these words—

"weapons systems or military operations." It is broader than that. That is correct, is it not?

Mr. JOHNSON. Yes.

The CHAIRMAN. In other words, there may be other military activities besides military weapons and military operations alone.

Mr. JOHNSON. I feel very strongly that is true.

The CHAIRMAN. You think the greater scope would be more important in the light of the world today; is that correct?

Mr. JOHNSON. Yes, sir.

The CHAIRMAN. Would you put into the bill language that, in the event of disagreement, then the decision be made by the President? You intimated that would be done on the Presidential level through Dr. Killian and his committee.

Mr. JOHNSON. I feel this, sir: That, if this language which is recommended were substituted, there would be no cause for conflict. It seems to me the worst that could happen may be duplication of effort. But if it was clearly stated that the Defense Department could proceed in exploration of space, as it understands it, for national defense reasons, then I think the civilian agency would operate in parallel, and I believe in many cases they would share this activity voluntarily.

I think the problem here is created because it is not clear that the Department of Defense—this is my opinion—would be permitted to operate without the approval of the civilian agency. If that is made clear, that they do not need the approval of the civilian agency, then I think there is no reason for conflict.

The CHAIRMAN. Are there any other suggestions to any other parts of the bill, appearing as Director of ARPA?

Mr. JOHNSON. No, sir.

I am in agreement with the bill as it is now written, if this clarifying language is adopted.

The CHAIRMAN. You mean, agreement as far as the Defense Department is concerned, as far as your activity?

Mr. JOHNSON. Yes, sir.

The CHAIRMAN. On other aspects like the State Department, I do not suppose you would pass on them anyway.

Mr. JOHNSON. That is right.

The CHAIRMAN. I just add that for the record so your position will not be misunderstood to anybody reading the record.

Admiral CLARK. Could I amplify that?

The CHAIRMAN. Certainly. Join in any time you feel like it.

Admiral CLARK. I think we should point out here that one control on all of this would be the Appropriations Committee. If a proposed program is not funded, then obviously this program does not go on. The reason for this particular suggested change in wording is that the original wording implies the Department of Defense must have a blueprint of a weapons system before we could proceed with space work or space exploration, and this is entirely contrary to the very definition of research.

You cannot prepare a blueprint or even conceive a weapons system until you have done the exploratory research that will give you the necessary knowledge for this sort of thing.

Now, the human factors are aspects—for instance, the services, the Army, Navy, and Air Force, for years have had a very intensive program to determine the human factors, what happens to a man in

space, and we are interested not only in whether he can survive in space but whether he can perform in space. There is little sense in sending a man up simply as cargo. We want him to be able to perform some useful function.

When we find out these things—what happens to a man in space, what are the phenomena that he is subjected to, how can he behave under a weightless situation—then we can begin to put together a blueprint for a weapons system.

The CHAIRMAN. In other words, before you are able to determine your mission and role you have to know whether you are able to do it?

Admiral CLARK. Precisely; yes, sir.

It is even possible that there will not be weapons systems per se in space. We may have reconnaissance and this sort of thing. But we feel there will be weapons systems. There always have. All research and scientific knowledge that has come over history has found an application in national defense, and certainly in this day and age our scientific secrets have war capability.

The CHAIRMAN. This is a little bit afield from the bill itself. I read in a national magazine a few weeks ago of a possibility of the Soviets soon being able to launch a spy satellite able to track planes by radar and simultaneously to direct missiles for plane interception. Can you give me any information on that?

Mr. JOHNSON. We have a very complete, I believe, project being sponsored by ARPA that leads to a reconnaissance satellite that will do a great many things for us. We are some months away from completion of this project, but I believe we are as far along as anything we know now of the Russians in planning such a satellite.

The CHAIRMAN. I am glad to hear that.

Could you give me any information as to the progress—I realize the difficulty you may have with classified information—but if it is not classified—progress in the same field as might be made by the Soviets?

Mr. JOHNSON. No.

The CHAIRMAN. I know you gentlemen recognize at all times we have to be capable of retaliatory action. That is one thing we must never lose. I know you gentlemen realize that just as well as I do, if not better.

The only level on which we can deal, as I see it, is the law of self-preservation. I have felt that way for years. They may say they deal on the moral law and the law of idealism, but they cannot deny that the law of self-preservation applies to their people as to ours, as well as to any people in any other country.

As long as their intent is world domination, about the only level I can see—unless there is a change in their state of mind—operating with them is the level of the law of self-preservation.

If this becomes a reality, the article also says, the power of retaliation by our bombers would be severely reduced or lost in time. Is that so?

Mr. JOHNSON. I believe there is a very definite military value in having reconnaissance satellites in orbit, and I believe if Russia has one that is fully qualified to inspect us they will have an advantage. I mean, if they accomplish this ahead of us.

The CHAIRMAN. This word "except" in this language interests me very much. I was concerned about that word "except", because I did not want to be a party to creating a civilian agency and then saying

that it cannot exist. Yet I appreciate thoroughly the importance of the military.

Is it understood—I ask this for the record—that in case of disagreement as far as the Defense Department is concerned—and you are speaking for ARPA in particular, and if you can speak, either one or both of you, for the Defense Department, I wish you would state it for the record—is it understood that where there are honest differences then it is intended and understood they can go to the President or anyone designated by him to pass upon the question as to where jurisdiction should be?

Mr. JOHNSON. That is the understanding of the Department of Defense.

The CHAIRMAN. In other words, it is felt that putting in specific language is unnecessary because it is understood that it is there by implication anyway?

Mr. JOHNSON. That is right.

The CHAIRMAN. Mr. Metcalf, of Montana.

Mr. METCALF. Thank you, Mr. Chairman.

As I understand it, Mr. Johnson, you are suggesting that parallel organizations be set up, one a military organization and one a civilian organization?

Mr. JOHNSON. That is right, sir.

Mr. METCALF. And when you leave this language in your amendment—"Congress further declares that such activities should be directed by a civilian agency"—and such activities are development, testing, and operation for research purposes of aircraft, missiles, satellites, and other space vehicles, manned and unmanned, together with associated equipment and devices, you are only saying that such activities as relate to civilian use are included?

Mr. JOHNSON. Yes, sir.

Mr. METCALF. In your testimony you say:

> If the Department of Defense decides it to be militarily desirable to program for putting man into space, it should not have to justify this activity to this civilian agency.

Then there is no need to go to the President, is there, to determine whether or not the Department of Defense program should be programed ahead of the civilian agency program or to work out any conflict?

Mr. JOHNSON. Yes, sir.

At the moment, I think it is the interpretation within the Department of Defense and NACA that, if this bill is enacted, a man-in-space program would have to be a joint effort of the two; that it could not be done by the military alone.

Mr. METCALF. But it is your position that the language should be written so the military could do that?

Mr. JOHNSON. That is correct, sir.

Mr. METCALF. Then you do not agree with this first statement—

> declares that such activities should be directed by a civilian agency—

except as civilian activities only should be directed by a civilian agency?

Mr. JOHNSON. Correct.

Mr. METCALF. And military activities should be over here [indicating], directed by the military agency?

Mr. JOHNSON. Yes.

Mr METCALF. Does not that do what the chairman suggested; that you create a civilian agency in name only?

Mr. JOHNSON. Sir, I believe there is scientific exploration—let me put it this way: At the moment, I believe anything between here and the moon has military implications. Beyond the moon, at the moment—and I do not want to predict for too long—I think that is a civilian scientific sort of exploration. That line I draw arbitrarily, the moon, may change as time goes on, but I do think that the military would not be particularly interested in exploring Venus and Mars at this time. But I believe the scientific fraternity, adding to our knowledge of phenomena in space should be an objective of the country, financed by the country.

Mr METCALF. But, as I gather from your testimony, it is the concept that the civilian agency should be the secondary agency in case of any conflict between the two.

Mr. JOHNSON. No, sir. I believe that both agencies should be permitted to go independent roads, if they desire. I think they should be instructed to work together to prevent duplication. I think parallel lines of work are sometimes desirable and duplication, I think, could be prevented. I believe you will get cooperation if it is clear that each can go their own course.

Mr. METCALF But if the military agency decides that a program is militarily justifiable, it is your idea that the Department of Defense should be able to put it into operation without any justification to NASA?

Mr. JOHNSON. Yes, sir.

Mr. METCALF Does not that relegate the civilian agency to a secondary position?

Mr. JOHNSON In military affairs, it does; yes.

The CHAIRMAN Who is going to determine what is military?

Mr. JOHNSON. I think that is a very, very good question, and this is what bothers me, because I think that the Department of Defense, the military services, are in a better position to decide that, and I think that we, as a country, would prefer to have that kind of a decision made in the Department of Defense, rather than the scientific fraternity.

The CHAIRMAN. I will agree that most questions probably could be easily resolved. That is understood. But there are some that could not

I am wondering; this gives the Defense Department conclusive jurisdiction in the determination of what is military. That is correct, is it not?

Mr. JOHNSON. That is right, sir.

The CHAIRMAN. I can see where it could be very easily clarified, I think, by the addition of a few words where, in the case of a difference of opinion, the President or anyone designated by him should make the decision. Would you object to that?

Mr. JOHNSON. No, sir. I think there will be cases when the President's Office will have to do that.

The CHAIRMAN. In practical operation, I can see where anyone would say, probably in 95 cases out of a hundred, "Well, this is military, having in mind the world today." And I realize the difficulty of divorcing what is civilian from military, and I think any doubt should be resolved, as far as myself, on the side of safety.

If there is any doubt as to whether it is primarily military, and so forth, the doubt should be resolved, in the world of today, on the side of the military. Just expressing my own opinion. But I can also see where there might be some twilight questions, and I would think, from the overall concept of our Government, that it is civilian—and we know that without going into detail—that, from the military angle, some language to that effect, where the President or someone designated by him would make the decision, would strengthen the military.

Mr. JOHNSON. Do you wish me to comment on that?

The CHAIRMAN. Yes.

Mr. JOHNSON. I think you could do it that way, but, as this program accelerates, there will be daily decisions that must be made, almost hourly decisions. I have seen in the last 60 days, the tempo increasing. I think that, actually, the time will come, if we go this road, where you may have to have a vice president in charge of space to be so knowledgeable of what is military and what is not military that he can be sitting making daily decisions every hour on the hour. I cannot conceive of any other way to answer this sort of thing if there is going to be a constant difference of opinion. And I can see these differences of opinion increasing as we in the Department of Defense do more military-science exploration.

I think, if you tell the Department of Defense that in military science you are limited to other fields than this, we are making a mistake, because I believe Russia is not inhibited by demanding that there be a military weapons system conceivable and immediately ahead before they explore military sciences.

I think our country has to do more of this, too. It is there where we will come into conflict with the civilian agency, because they will say, "Well, this scientific effort has no military implication in it," and we will argue that it might. I think this could be a daily occurrence.

The CHAIRMAN. Is it not better to have some means of avoiding that, or at least having a decision made? Those questions are bound to arise.

Mr. JOHNSON. Well, sir, there are many fields of science that the Defense Department is now permitted to explore, and ARPA was set up to forward that kind of thinking in terms of complex work, such as defense against missiles. We have to begin now to study the phenomena that we have not studied in the past, on a more scientific basis. I think if we start now to exclude one field of science from the military, their operating freely in it, this would be a bad precedent.

The CHAIRMAN. I see you have in your proposed amendment the word "except," which sort of disturbs me. I create something and then I say "except," and that has a very deep significance to me.

Mr. JOHNSON. The word "except" is in the bill itself.

The CHAIRMAN. I know that. That concerns me in the bill.

Mr. Metcalf?

Mr. METCALF. Mr. Chairman, I am concerned, too, about the word "except," as written in the bill, and the ambiguity of the language. So, I am glad these witnesses brought it up. But, in taking the language of the suggested amendment along with the statement that has been presented here—if the Department of Defense decides it to be militarily desirable—it seems to me that puts the last word of authority in the Department of Defense. Is that what you intend to do?

Mr. JOHNSON. I think, as Admiral Clark has pointed out, this work will have to be approved every year by Congress in its appropriations. I do think that the President's Office would step in any time and arbitrarily make determinations contrary to the decision of the Department of Defense that an effort was military. I think we have the checks and balances in our present system that would make it impossible to go overboard as long as the space activities within the Department of Defense were centralized, as they are, in ARPA.

Mr. METCALF. But there would never need to be a resolution of the Congress between the civilian agency and the military agency, because, if the Department of Defense made a decision that a program was militarily desirable, it would have the last word in deciding whether to go forward with it, except, as you say, to justify it before the Appropriations Committee.

Mr. FORD. Would you yield?

Mr. METCALF. Surely. I yield to the gentleman.

Mr. FORD. It seems to me, when the budget is put together, as a practical matter, the Bureau of the Budget, in reviewing the funding requests by the civilian agency and the Department of Defense on behalf of ARPA, would make a decision as to the allocation of funds, and through the allocation of funds there would be a decision made as to whose responsibility it would be. Is that the way you think it would work, Mr. Johnson?

Mr. JOHNSON. That is correct, sir. I think you would have a wonderful control.

Mr. FORD. You see, before they can get the money, even request it of Congress, they have to justify their individual projects to the Bureau of the Budget, and, in that process of justification, a decision as to whether the program, A or B, would fall.

That is the initial decision, and then, of course, the Congress, in the approval of the respective budgets, would confirm or reject which agency would have the responsibility. Is that your interpretation of the way it would act, from a practical point of view?

Mr. JOHNSON. That is correct, sir.

Mr. FULTON. Will the gentleman yield on that point?

Mr. METCALF Yes; I will yield.

Mr. FULTON. What standards would the Bureau of the Budget use in making that decision? How would they formulate rules of general nature to come to such decisions?

Mr. METCALF. I agree that the Congress, through its appropriating function, would have a sort of a last word, but it has the last word no matter what kind of an agency we establish. If this committee would introduce, and the Congress would adopt, legislation that says that control of space shall be under the military, we would have the same appropriation control that we have under the suggestion you have made.

But it seems to me that the language in the bill—

Congress declares that such activities should be directed by a civilian agency—

is completely canceled out by the suggestion you have made and the testimony that you have presented. I am not in a position to say here whether or not it should be canceled out. I am just trying to get my thinking in line with yours. I cannot see how we are protecting anybody by this appropriating function that you suggest.

Mr. JOHNSON. I think the control of money is always the final control.

Mr. METCALF. That is granted, but that is here and inherent in our present system; no matter where we put the Space Agency, there will be this appropriating function and determination in the Bureau of the Budget.

Mr. JOHNSON. But, within specific approved programs, there is still the possibility of a great deal of leeway as to, for example, a man in space. The military have very definite ideas of the things they want a man to do in space. The civilian agency may have different ideas. To the degree that the military scientific explorations proceed as they wanted them to, to get the kind of data they wanted within that money, I think it is a very, very important decision to have remain with the Department of Defense.

Mr. METCALF. What would a civilian agency be doing now in space, except working on explorations on the other side of the moon?

Mr. JOHNSON. Sir, I feel that the civilian agency has a need for scientific exploration and the construction of vehicles that are necessary for that exploration. There is, I think, 20 years of exploration that will keep an agency very well occupied to get new data, new information which I do not think the military, at the moment, would be as interested in exploring.

Mr. METCALF. What would such a civilian agency be doing in the field of missiles?

Mr. JOHNSON. I cannot think what a civilian agency would want in the field of missiles.

Mr. METCALF. The bill says—

for the development, testing, and operation for research purposes of aircraft, missiles, satellites, and other space vehicles—

and it says—

such activities should be directed by a civilian agency.

Mr. JOHNSON. I presume the kind of missile a civilian agency would need would be a missile with a million, 2 million-, 3 million-, 5 million-pound thrust, an extraordinary thrust you would not need in an ICBM. To that degree, they would have an interest.

But missile technology is so wrapped up in the Department of Defense in dozens of projects of large magnitude, I do not think a civilian agency would want to start in and go on its own in a program of that kind. Certainly, they would rely on the military work to a great degree for cost reasons.

Mr. METCALF. Do you think that word "missiles" should be deleted for the purposes of clarity?

Mr. JOHNSON. No; I do not think that I would inhibit the civilian agency from proceeding, if they wanted to; the military may decide they were not interested in a 2 million-pound thrust, and they should not be precluded from developing one of their own if the military did not want to.

Mr. METCALF. Thank you.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Mr. Johnson, as you probably know, a number of outstanding scientists in the country have appeared before our committee during the past 2 weeks. These gentlemen have made certain observations concerning this particular matter that our chairman has pointed out to you.

One of the scientists who appeared before our committee made a statement, Mr. Johnson, Prof. James A. Van Allen, the department of physics of the University of Iowa. He made two observations I would like to read to you and see whether or not you agree with them. The first one is this:

There will likely be many useful military applications of the results of space research. But, in my judgment, a much broader and more fruitful national program will result if the program objectives are not set by the demonstrated needs of military weapons systems and of other military applications.

Mr. Johnson, he made the further statement, and I will read it:

In the above it has been urged that the NASA be given dominant cognizance, among all Federal agencies, in the exploration and peaceful applications of outer space. The national security requires that the activities of NASA not adversely affect the development of specific weapons systems and the accomplishment of other short-term, specific military objectives. Decisions on the proper cognizance of areas in which a conflict of interest with the Department of Defense exists should be made, in general, in favor of the NASA—unless a clear and significant loss of military preparedness can be demonstrated to result thereby.

How do you feel about those two observations?

Mr. JOHNSON. I would disagree with Dr. Van Allen. I come back to the point I made earlier. I think it would be a tragic mistake to tell the Department of Defense that it could not explore a field of science unless there was a clear-cut military objective or a military weapons system in the planning. I believe that this would be a mistake.

Admiral Clark would like to comment.

Mr. NATCHER Go right ahead, Admiral

Admiral CLARK I would like to point out, first, that the bill does not restrict itself to astronautics, it also says aeronautics.

I question whether we would be farther ahead in aviation today if all of our aviation activities in this country had been under the direct control and management of a civilian agency. The things that have made our airlines great have been the work that has been done for military aircraft—large engines and this sort of thing.

Now, the NACA was during the same period making spectacular contributions, a wonderful organization, and one of the very reasons it was established. I think it could make the same contributions in astronautics and should.

Mr. NATCHER. Admiral, do you agree with the two observations I have just read that were made by Professor Van Allen, or do you disagree with the two statements?

Admiral CLARK. In the first statement, he said there would be——

Mr. NATCHER. Let me read it again right quickly. His first observation was:

There will likely be many useful military applications of the results of space research. But, in my judgment, a much broader and more fruitful national program will result if the program objectives are not set by the demonstrated needs of military weapons systems and of other military applications.

Admiral CLARK. I disagree with it, because the programs we have right now are not tied to a weapons system, pointed to a weapons system, they are pointed at the obvious things—reconnaissance. Reconnaissance is going to have a great interest to the civilian approach if we can predict weather and we learn a great deal about that part.

Now, the civilian scientific approach, it seems to me, would have a great interest in research which points to a better life to man on earth,

perhaps in the field of agriculture, medicine. Since we never know what scientific research is going to turn up, we might get clues as to the cause of cancer, this sort of thing.

Mr. NATCHER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. I would like to ask Mr. Johnson with reference to the bill: As I understand, you are generally supporting this legislation we have before us, with possibly some changes as you suggest in this proposed amendment.

On page 3, section 4, where it is proposed to set up a board—I am referring now to line 20 on page 3—where no more than 8 members of the board are to be designated from appropriate departments and so forth, concluding with this language, "including at least 1 shall be from the Department of Defense."

Do you agree, in general, with the proposed setup for the membership on this Board, Mr. Johnson?

Mr. JOHNSON. I do not disagree. I think that it is possible under this language for the Department of Defense to be represented by more than one. As long as one representative is there, while I cannot speak for the entire Department, I think this is all right.

Mr. SISK. You think, then, that one member of the Department of Defense would be sufficient on this 17-man Board?

Mr. JOHNSON. Yes, sir.

Mr. SISK. We have had some testimony before us here—in fact, I think that almost without exception people from the military heretofore appearing before the committee have indicated they felt there should be at least 3 or 4 on this Board. Generally, I think the recommendations have been by several generals and admirals, both in the Army, Navy, and Air Force, that possibly there should be a representative from the Department of Defense who would be a civilian, and then possibly a representative from the three services.

You do not necessarily agree with that suggestion?

Mr. JOHNSON. I would not object if the language were changed to include representatives of the three military services as well as the Department of Defense. This would give continuity in the event of failure of the Department of Defense member to perform. I think that would be desirable.

Now, I am of this opinion: If the language is not changed, my recommendation is not followed, then I would certainly want stronger representation from the Department of Defense, because I think this becomes very critical then in the policy area.

Mr. SISK. In other words, that is what I am arriving at, Mr. Johnson.

As I understand you, this Board for control of space, this lunar space, must be under the control of the Department of Defense. If you can put in language here which will make the new Agency subservient to the Department of Defense, then you do not particularly care whether you have any representation on the Board or not. If you cannot get that kind of language in it, of course, you can see where you would want substantial representation. Is that not about right, Mr. Johnson?

Mr. JOHNSON. Not quite, sir. I would like to say it this way: That honestly I do not feel there is any need to say the civilian is subservient to the military or that the military is subservient, either

one to the other, if each are allowed to work out their own program and encourage to work together. I do not think the word "subservient" needs to become important here.

Actually, what I am concerned about is that a civilian agency will be set up that will be literally in control of all space, and this law, as it is worded, would mean all space one inch from the ground, not a hundred miles up.

The language here says that this Agency will control all space starting with this floor. And I think this is a very radical step to take, to put all space in civilian control.

Mr. SISK. For all practical purposes, we are a Nation believing in civilian control of all aspects of our Government. So that, in essence, even our military forces themselves are under civilian control and under a civilian Commander in Chief; is that not correct?

Mr. JOHNSON. Yes, sir.

When I said civilian control, I am sorry, I meant civilian agency control. I should have put in the word "agency" I think there is a distinction.

Mr. SISK. Actually, you made the statement a little while ago that you felt—if I understood your statement—that you felt there was substantial possibility for military exploration or military usage of the area I referred to as lunar, or that area of space out to the moon, and it would seem to me then that your discussion would more or less preclude any operational activities on the part of the new Space Agency in that particular area

I think that you possibly indicate that in basic research, yes; but in the practical application of an operational agency and operating vehicles, and so forth, in space, it must almost be under the domination of the Department of Defense, or at least subject to their veto.

Do I misstate that, Mr Johnson?

Mr. JOHNSON I would like to come back now again—as I interpret the language of this law, the law says that this civilian agency is going to be in control of all space, not just outer space, except for a military weapons system. I do not think that my suggested language would imply the military would be ruling the airlines or ruling civilian air transport. I think that there would be no more concept of that in outer space than there would be in space up 10 miles.

Mr. SISK You refer in your statement—and I believe possibly the gentleman from Montana referred to part of what I have in mind—on page 3, you mention that ARPA coordinates with other agencies outside the Department of Defense, such as the National Advisory Committee for Aeronautics, the National Academy of Sciences, and the National Science Foundation.

I have been concerned from the very beginning of these hearings with just where ARPA would fit into the situation in the future. That is, assume we set up a new space agency.

Let me ask you this: Just what do you propose a new NASA would do and the authority it would have above and beyond what ARPA, NACA, the National Academy of Sciences, and the National Science Foundation are doing and have authority to do today?

Mr. JOHNSON. I have asked myself that question.

Mr SISK It comes right down to this, Mr. Johnson, actually: Do you feel there is any need for this new Agency?

I mean that sincerely. I am not trying to get an argument with you. I appreciate your position.

I am just sincerely concerned, and I have sat here for the past 3 weeks and listened to the testimony on this and have really begun to seriously consider whether or not there is any particular niche for this new Agency unless we eliminate some of the present agencies, or just where it is going to fit in, just what authority it is going to have, just what capacity to operate that some of these other agencies do not already have, unless it becomes an overall guiding agency with authority to make decisions not only with reference to the Science Foundation and the Academy of Sciences but to ARPA and any other organization as well. I am becoming increasingly concerned about the usefulness of it at all.

Mr. JOHNSON. This bothers me, too, sir.

Mr. SISK. We approached this in the beginning, Mr. Johnson, with the idea there was some urgency about this. I realize the urgency, which I think was brought on because of a military situation. Would you agree with that?

Mr. JOHNSON. Correct, sir.

Mr. SISK. ARPA was set up primarily, then, as you visualize, to meet that military challenge; is that right?

Mr. JOHNSON. It was one of the reasons for establishing ARPA; correct.

Mr. SISK. Primarily it was an attempt to coordinate and to do the things that were necessary to meet the possible military challenge of a possible enemy country; is that correct?

Mr. JOHNSON. I think that is substantially correct, sir.

Mr. SISK. Let me ask you one further question here.

There has been quite a bit of testimony with reference to the need for an international understanding in space exploration due to the enormity of the task and the fact that it would be most desirable that space be kept peaceful and exploration of space be done in a peaceful manner and used for peaceful benefits.

What is your opinion, in general, on that? Do you think there are any possibilities of that? I mean, for all nations of the world.

Mr. JOHNSON. Sir, I think that, we should do it within the framework outside of the Communist bloc, paying the money, but perhaps sharing a knowledge with the other nations of the free world. We will do this anyway.

I think we might otherwise invite management problems that would injure or harm our progress. I believe we are better equipped to do it on our own.

I think the Russians will do it on their own. I think they clearly intend to. They recognize the opportunity here.

I think we must face up to this as a nation. I do not think we are going to run away from this problem by trying to push it off on the U. N. There is a little bit of fear psychology in this problem, I believe. The unknown now is bothering us, and I think there is a desire to say we can run away from this thing by wishing it to be civilian, to be peaceful, and to put it in the United Nations, and I do not think any one of those things is going to work.

We have to face up realistically to the new problem that is created for us on this world in our national security, and I do not think we can lose sight of that for one minute.

I do not want to make a speech, but I feel very strongly about this.

Scientists have said it is ridiculous to put a man in an instrument or satellite up there and drop a bomb, because the bomb will not drop. So we are supposed to believe this is ridiculous.

Actually, we do not know what the weapons of tomorrow are going to be. Work over the next 20 years might lead to a death ray, and if you had a death ray, that would be the weapon of tomorrow, and then obviously a man in a satellite up in the sky would be in a far better position to use judgment, to exercise control of that ray.

So what I am saying is: let's not look at the problem of tomorrow in terms of weapons of today and just automatically say that there will be no military uses of space way out, including the moon. If we think in terms of present weapons, that is probably right.

The bomb today is considered the ultimate weapon. I suspect 20 years from now the bomb will be passé as a weapon.

Mr. SISK. Getting back to the bill for just a moment again, Mr. Johnson, on page 2, on line 22, under subsection 6, we have these words in a statement of policy:

"Cooperation by the United States with other nations and groups of nations in work done pursuant to this act and in the peaceful application of the results thereof."

Of course, some think that is just high sounding language, but that is part of the declaration of policy.

As we discuss this further, I am becoming increasingly inclined to believe that on a close analysis of this bill, Mr. Johnson, you might find a number of things that you might not agree with in the legislation.

What do you think of that particular language?

Mr. JOHNSON. The International Geophysical Year was, I think, a wonderful thing. Even the Communist nations participated. I think that concept ought to be encouraged.

I think we are now in the framework where we can get scientists of different nations to do more work together. As it extends our knowledge of phenomena of space, I think it is a good thing.

But what I said earlier is that I do not think we can wish our problem off onto that body and say, "We have solved it, and we need not fear enemy attack from outer space because we have turned it over to peaceful scientists." I do not think that would follow, but I think it is a good thing.

Mr. SISK. I appreciate the discussion we have had this morning. I have been criticized by certain people with reference to a statement I made to the effect that, if all we were doing here was changing the name of some agency and winding up doing business as usual at the same old stand, all we were doing was spinning our wheels, and I am coming more and more to believe possibly I was right in that.

I realize the urgency, I think, of progress in this field, but I am wondering, after having heard your answers to some of the questions, if to some extent you might not be inclined to agree with my statement.

You do not have to answer that question. I do not want to put you on the spot.

Mr. METCALF. Will the gentleman yield?

Mr. SISK. Yes.

Mr. METCALF. In the same list of activities the gentleman from California was referring to is item No. 3:

that the activities should be conducted so as to contribute materially to the development and operation of vehicles capable of carrying instruments, equipment, and living organisms through space.

In your testimony you said if the Department of Defense decided it to be militarily desirable to program putting a man into space, it should not have to justify this to a civilian agency. As the bill is written, a civilian agency would be in control of putting a man into space. Is that not correct?

Mr. JOHNSON. This is a disputed area, and we have agreed to compromise, as you do in a dispute, and so we are saying now that we will share the responsibility between the two agencies.

Mr. METCALF. If the language you have submitted as an amendment were adopted, the Department of Defense would have the final decision?

Mr. JOHNSON. No, sir; no. The civilian agency—this clause I would not change, and I think the civilian agency ought to operate vehicles in space for exploration purposes that have no military implications. But if we put a man up there for military reasons, he may be in an environment, he may be asked to do things that you would not in a civilian agency ask a pilot of that satellite to do.

We ought to be free to create the kind of vehicles we need to protect us militarily, and they ought to be able to—it is just the same thing as a bomber and a passenger aircraft. Civilian agencies make passenger planes, the military makes bombers. There is no problem.

Remember now the language of this law also applies, I think to lower space as well as outer space, and presumably this Agency could operate vehicles in lower space as well.

Mr. METCALF. Suppose this language is left in the upper part of section 2 just as it is contained in the bill, and there is a conflict between the Director of NASA and the military as to who should direct a program for putting men into space, who would determine and decide that conflict?

Mr. JOHNSON. Well, sir the disagreement probably would be between my Agency and this new Agency. I would then go to the Secretary of Defense. If he agreed with my viewpoint, then presumably the Secretary of Defense and the Director of this new Agency would meet at Cabinet level, and attempt to settle the dispute between themselves. That failing, then I think they would go, obviously, to the President.

Mr. METCALF. And this is the only way in which a conflict could be resolved between ARPA and NASA?

Mr. JOHNSON. If the Secretary of Defense agreed with ARPA.

Mr. METCALF. Unless there is some additional language put in the bill?

Mr. JOHNSON. Correct, sir.

And I think the question there is, as time goes on, the day-to-day operating decisions that will be held up depending on clarification, which may become a great number, and this could be a very onerous task for the President of the United States to take on.

Mr. SISK. I have only one further question, Mr. Johnson, and that is this:

Do you believe that ARPA as it is presently constituted, with the power and with the authority it has, is capable of doing the job in

space, militarily speaking, to place us once more in a position of leadership in the world in the use of aeronautics and astronautics so far as its military application is concerned?

Mr. JOHNSON. Yes, sir; I do.

If the Congress approves the 1959 budget for the money we have requested, I am convinced that it is adequate to do this job and to do it at a reasonable cost.

Mr. SISK. Then do you not feel that the NACA, as presently organized, the National Science Foundation and the National Academy of Sciences are probably doing a capable job in the civilian research field in space today?

Mr. JOHNSON. Well, the research that has been done in 1958 has been very largely in the Vanguard program, which will cost in total maybe $110 million, and we have authorized using the Jupiter-C where there will be spent in 1958 perhaps another, I guess, $4 million. So we would be spending for civilian research in space $114 million. I think that is a pretty good number for the first year. This is calendar 1958.

Mr. SISK. So you feel with the present committees and organizations, both military and civilian, properly constituted, we are doing a job?

Mr. JOHNSON. I do, sir. Although I would like to say this:

That the budget I submitted is primarily a military budget. It does not include some civilian work that needs to be done. I do think that there is another program in scientific exploration that is not militarily valuable for the foreseeable years that should be done and ought to be included in money appropriated for the NACA——

Mr. SISK. That could be done——

Mr. JOHNSON. Or the Science Foundation or any other group.

Mr. SISK. That could be done simply by giving NACA additional contract authorization by the Congress and increasing their appropriation; right?

Mr. JOHNSON. Yes, sir.

Mr. SISK. Thank you. That is all.

The CHAIRMAN. What is that program?

Mr. JOHNSON. What program?

The CHAIRMAN. The one you just mentioned that you feel should be done that is not included in the present program.

Mr. JOHNSON. We included in our budget $72 million for additional—let's call it a satellite and a half a month through 1959. That would be scientific exploration.

There is a lot more we need to know about what is going on out there, and the best way to do it is with a satellite. That is a minimum program.

There is other work that needs to be done now in instrumentation and more telemetering equipment and that sort of thing, which needs to be added to the total effort.

We did not include that in our budget because we presumed that money will be appropriated to a civilian agency. Therefore, I do think that you must not take our budget and say that is good enough for the total space effort. More money is needed.

The CHAIRMAN. These questions lead up to what I interpret in the minds of some of the members—that under the bill there is not an overall control on policy over the whole space program, for example,

between ARPA and NASA, setting up priorities and making allowances, and so forth.

The questions asked by the members, as I interpret, are really connected with the fact that there is lacking an overall control so far as policy is concerned.

The President's reorganization plan for the Department of Defense, on which hearings are now being held by the Armed Services Committee, provides that the present Assistant Director of Research and Engineering shall become the Director of Research and Engineering who shall supervise (1) the Director of ARPA, and (2) the Director of Guided Missiles.

Mr. JOHNSON. Would you care for me to amplify my interpretation of that language?

The CHAIRMAN. Surely.

Mr. JOHNSON. The Secretary of Defense intends that the Director of ARPA and the Director of Guided Missiles shall continue to report directly to him as they have in the past. ARPA will have its budget as approved by Congress. It will be an operating agency, will have funds, and will let contracts.

The CHAIRMAN. Will he be under the new official provided for in the reorganization bill?

Mr. JOHNSON. Under the reorganization bill, it is my understanding it is not intended for the Director of Research and Engineering to have funds of his own.

The CHAIRMAN. To have what?

Mr. JOHNSON. Funds, money. But ARPA will have money.

The CHAIRMAN. How will that affect ARPA? Will that bring about any administrative effect in the work of ARPA?

Mr. JOHNSON. I will be glad to give you a copy of a letter we have in our records, signed by Dr. Foote, Mr. Holaday, and myself, where we have a working arrangement as to how we coordinate between each other, the directions we give where we need to in our field, and I think this is the way we will continue to work. All ARPA projects are looked at by the Assistant Secretary of Research and Development.

The CHAIRMAN. Will you put that in the record?

Mr. JOHNSON. We will be glad to.

(The information follows:)

OFFICE OF THE SECRETARY OF DEFENSE,
Washington, D. C., April 7, 1958.

MEMORANDUM FOR THE SECRETARIES OF THE MILITARY DEPARTMENTS; THE CHAIRMAN, JOINT CHIEFS OF STAFF; THE ASSISTANT SECRETARIES OF DEFENSE; THE GENERAL COUNSEL; THE ASSISTANTS TO THE SECRETARY OF DEFENSE

The attached memorandum and chart delineate the relationships between the Assistant Secretary of Defense (Research and Engineering), the Director of Guided Missiles and the Director of the Advanced Research Projects Agency, pending Department of Defense reorganization along the lines recently proposed by the President

The Secretary of Defense has approved the dissemination of this memorandum and chart for the information and guidance of all concerned.

PAUL D. FOOTE,
Assistant Secretary of Defense (Research and Engineering)

WILLIAM M. HOLADAY,
Director of Guided Missiles.

ROY W. JOHNSON,
Director, Advanced Research Projects Agency.

OFFICE OF THE SECRETARY OF DEFENSE,
Washington, D. C., April 7, 1958.

To: The Secretary of Defense.
From:
The Assistant Secretary of Defense (Research and Engineering).
The Director of Guided Missiles.
The Director, Advanced Research Projects Agency.

PROBLEM

To delineate the relationships between the Assistant Secretary of Defense (Research and Engineering), the Director of Guided Missiles and the Director, Advanced Research Projects Agency.

DISCUSSION

The ASD (R and E) is the staff adviser to the Secretary of Defense on all military research, development and engineering matters. He is responsible for recommending to the Secretary of Defense basic policies governing military research, development, and engineering efforts by DOD activities and for recommending an integrated DOD research and development program to meet military requirements which will assure that there are no gaps and will eliminate undesirable duplication. In order to carry out effectively these responsibilities, he must be informed on all military research, development, and engineering efforts within the DOD, including those research and development projects assigned to the Director of Guided Missiles and the Director of ARPA.

In carrying out his responsibility to advise the Secretary on all research and engineering proposals within the DOD, the ASD (R and E) must determine that the proposals are technically sound, administratively feasible and in consonance with the overall policies and program objectives of the DOD. He provides through his own staff for the technical reviews and program analyses of all military department research and development projects except those assigned to the Director of Guided Missiles in which case he utilizes the staff reviews and analyses made by the Director, supplementing or complementing these to the extent necessary to insure that all aspects of these programs are covered. So far as ARPA projects are concerned, the responsibility of the ASD (R and E) is the same as for the military department research and development programs, but as in the case of the Director of Guided Missiles, the ASD (R and E) utilizes the ARPA staff technical and administrative reviews to the extent that these satisfy his requirements.

The Director of Guided Missiles is a staff assistant to the Secretary of Defense with certain delegated line authority for the direction of all activities in the DOD relating to the research, development, engineering, procurement and production of guided missiles. The staff functions that he performs with respect to the research, development and engineering efforts of the DOD for guided missiles projects are similar to those performed by the ASD (R and E) for all other military research, development and engineering projects. The difference is more a matter of emphasis and scope than anything else. He is an expediter who is responsible for one principal segment of the total research, development and engineering effort plus the procurement and production aspects after development is completed. The Director of Guided Missiles looks to the ASD (R and E) for advice and assistance in broad research and development fields (such as basic research, electronics, fuels, materials, nuclear applications and piloted aircraft) which are not exclusively involved in guided missile projects, but may have an effect on those projects He performs the technical reviews and program analyses for all guided missile projects and keeps the ASD (R and E) and the Director of ARPA informed on status of an important achievements and requirements in the research and development aspects of guided missiles.

The Director of ARPA is primarily a line official with responsibility for planning and directing advanced research projects involving space science and technology, ballistic missile defense, and other advanced research and development, as assigned, by the Secretary of Defense. In this role, he deals only in the research and development aspects of projects assigned to him. Ordinarily, these projects will be of a nature which would be outside the assigned missions of the 3 military departments or would be of interest to or involve 2 or more military departments and it would be in the best interest of the department to have an agency not a part of one or more of the military departments to pursue the research and development effort. When a project assigned to ARPA has passed beyond the research

and development stage, it will be assigned to one or more of the military departments or other appropriate agency for engineering, production, and utilization. In addition to the line responsibility, the Director of ARPA serves in a staff advisory capacity to the Secretary of Defense for certain matters such as recommending proposals for advanced research which may be conducted by his agency, or under his supervision by the military departments, and performing technical reviews and program analyses for research and development projects assigned exclusively to ARPA. The Director of ARPA is also responsible for keeping the ASD (R and E) and the Director of Guided Missiles informed on the status of and important accomplishments and requirements in his assigned projects which may have an effect on their assigned projects or responsibilities. He also looks to the ASD (R and E) and the Director of Guided Missiles to keep him informed of the accomplishments in their respective assigned projects which might have an effect on his assigned projects.

The relationship between all three individuals is one of close interdependence from the standpoint of keeping each other informed as to the breakthroughs, advances and requirements in their respective fields. The Director of Guided Missiles and the Director of ARPA probably have a closer and considerably different relationship than either has with the ASD (R and E), because many of the vehicles and components, developed for military weapons systems under the direction of the Director of Guided Missiles may be utilized by the Director of ARPA in research, experimentation and testing of certain vehicles or components required for the exploration of outer space as well as for anti-missile-missiles development. Similarly, it is expected that new scientific knowledge, advances and improvements discovered in the research and experimentation projects conducted by the Director of ARPA may be utilized to effect improvements in the research, design, and development of guided missiles carried out under the direction of the Director of Guided Missiles. On the other hand, both of them are dependent upon and utilize advances and breakthroughs in the broad fields of research and development specifically assigned to the ASD (R and E) and vice versa.

As long as the total effort in weapons research and development is adequate to meet the weapons requirements of the military services and the quasi-military requirements for outer-space exploration, there will be no problem. If the effort is not adequate, then priorities will have to be established by the Secretary of Defense. The attached chart depicts graphically the working relationships between the ASD (R and E), the Director of Guided Missiles and the Director of ARPA as outlined herein.

IMPLEMENTATION

If you concur, a joint memorandum presenting the above statement of relationships together with the attached chart will be published for the information and guidance of all concerned.

RECOMMENDATIONS

That you approve and authorize the publication of the proposed joint memorandum and chart.

The CHAIRMAN. In other words, the authority of ARPA to make contracts now would not pass to the new Director of Research and Engineering?

Mr. JOHNSON. It would not.

The CHAIRMAN. Mr. Fulton.

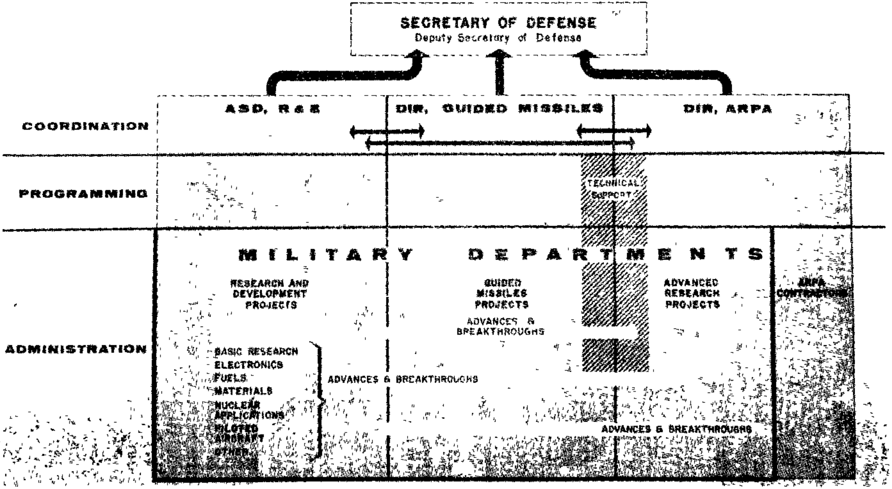
Mr. FULTON. I am glad to have you here.

In order to clear up a previous point that has been discussed, there was a question of the Bureau of the Budget deciding which would be military and which would be civilian space programs.

My question has been previously: What standards would the Bureau of the Budget use in coming to such a decision?

Referring to the discussion here between Mr. Metcalf and Mr. Ford, in which it was commented that possibly the money power of the Budget would really be deciding the function between the civilian and military, actually the inference to my question is that I thoroughly disagree with that, that I do not believe that is the place for that decision to be made between civil or military space programs.

DEPARTMENT OF DEFENSE
RELATIONSHIPS AMONG R&D ACTIVITIES



Mr. JOHNSON. This is the way it works. It is my understanding, however, that after moneys have been finally approved there is some freedom within programs using those moneys.

Mr. FULTON. You see, not that this is the way it works, but how should this committee plan that the best decision should be made in the future?

Mr. JOHNSON. I think that we have here a case where, if the Department of Defense is in disagreement with the Bureau of the Budget, then, too, we would have to go to the President for the final adjudication before the appropriation is submitted to the Congress. This does work now.

I think this new system, or this system we are talking about as it affects space would be functioning in that kind of an environment.

Mr. FULTON. Why not have an overall Space Agency which carries out the national space policy as outlined by Congress and legislated by the Congress? This Agency would have a seven-member commission form of government and would have on it military as well as civilian representatives. It might have under it the existing NACA structure as well as another structure that may be called NASA, the Astronautics, and it might have as a member of the Commission, for example, the Director of ARPA, or Dr. York, the scientist.

Mr. JOHNSON. I certainly think this is one way to do it. The problem, as I see it, is simply this: If many years ago the Atomic Energy Commission had been set up on the basis of atoms for peace, and it had been atoms for peace oriented, I do not believe the Congress over the years would have—and this is purely a personal opinion—appropriated the money needed to carry it where it has gone. I do not believe that the military aspects of atomic energy would have been prosecuted with the same force. This is a personal opinion.

The problem, in my mind, when you create this kind of an agency, if it is oriented to be atoms for peace, space for peace, then as a citizen I will be greatly concerned about the end result and the national security.

Mr. FULTON. The alternative, as you suggest, is based on space for war.

The CHAIRMAN. May I interrupt?

Mr. FULTON. Yes.

The CHAIRMAN. I am Acting Speaker today, so I have to leave. I have other jobs and other duties. And two of the members have to be on the floor.

After Mr. Fulton finishes, could you come back at 2:30?

Mr. JOHNSON. Yes, sir.

Mr. FULTON. The alternative that you leave open then, is, if you emphasize the fact that atoms might not have produced such a good result if it had not been first military and then expanded, when you apply that reasoning to the future space program it comes up against the alternative of having space used for military purposes, which in the end means war.

Now, I am always intrigued by every person who comes up before congressional committees from the executive departments and agencies because they are always willing to save the country, but preferably through their own departments.

Mr. JOHNSON. Yes.

Mr. FULTON. They think that is the best way to save it. So I compliment you on running true to form, and it is rather a good view on what you think your Department has done.

The problem then comes up: Shall we have two space policy-setting bodies, one for security or war purposes, the other for peace and exploration purposes, and then have the Office of the President act as the arbiter from day to day, week to week, and month to month as the various projects come up?

To me, that is putting too big a burden on the President and is an impossible method of avoiding the decision, the belief that Congress should set up an overall Space Agency under a policy guidance by the President, with the administration of the Agency in its seven-member Commission, on which both military and civilians sit, having unison—it may be Astronautics or ARPA or the various Army Ordnance components—but that Congress itself should set the standards of what is military and what is civilian as to the program in space, leaving the Agency to work out a method of operation.

Do you agree with that?

Mr. JOHNSON. I do not think I could give an offhand opinion on that.

Mr. FULTON. Would you submit it in the record?

Mr. JOHNSON. I will do so; yes, sir.

Mr. FULTON. In the bill itself there are provisions that give a period of time within which a particular agency can, by its own consent, transfer facilities and personnel to the new NASA Space Agency, but there is no particular way that the National Space Agency can get those facilities and personnel by order of the President if the Agency just sits down.

Do you think it should be set up so the President is specifically given the power and authorization to direct ARPA or the Department of Defense to turn over to the National Space Agency programs, facilities, personnel, and equipment?

Mr. JOHNSON. I again would not like to answer that off the cuff. I would like to be permitted to have some time.

(Mr. Johnson later submitted the following letter:)

GENERAL COUNSEL OF THE DEPARTMENT OF DEFENSE,
Washington, D. C., May 12, 1958.

HON. LYNDON B. JOHNSON,
Chairman, Senate Select Committee on Space and Astronautics,
Washington, D. C.

DEAR SENATOR JOHNSON: Mr. Roy Johnson, Director of ARPA, and I left an executive session of the House Select Committee on Space and Astronautics at 4 o'clock this afternoon, at which time he had an engagement to fly to Massachusetts with a group of other persons on a mission connected with ARPA activities. He asked me at that time to write this letter to you on his behalf, in order to fulfill his undertaking to let you know if language was developed which was satisfactory to him to alter the provisions of S. 3609 (and the corresponding House bill), in order to meet the concerns which he had with the original language of those bills.

As a result of consideration of the matter today before the appearance of Mr. Roy Johnson before the House Select Committee, Mr. Johnson was able to report substantial agreement within the executive department upon the following two changes in S. 3609:

First. Strike out on lines 9 and 10 the following:

", * * * in which case the Agency may act in cooperation with, or on behalf of, the Department of Defense."

Substitute for the language thus stricken out the following:

"in the case of which activities the Department of Defense shall be responsible."

The whole sentence beginning on line 4, as a result of the above change, will read as follows:

> "The Congress further declares that such activities should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States, except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations, in the case of which activities the Department of Defense shall be responsible."

Second, on page 3, line 20, substitute the single word "nine" at the beginning of the sentence for the four words "no more than eight"; and also on line 23 substitute the word "three" for the word "one".

The provision thus amended, appearing on lines 20 to 23 inclusive of page 3 will, therefore, read as follows:

> "(1) Nine of the members of the Board shall be designated from appropriate departments or agencies of the Government of the United States, including at least three who shall be from the Department of Defense."

Mr. Johnson testified that with these changes he believed that his expressions of possible concern had been met and that the bill as thus changed was in his judgment entirely satisfactory.

Very sincerely,

ROBERT DECHERT.

Mr. FULTON. You can include your views in the record.

On the $72 million you recommend for civilian space projects during the coming fiscal year, do you not think that a recommendation of 86 percent for military and quasimilitary as against 14 percent for civilian program projects in space is rather a lopsided recommendation?

Mr. JOHNSON. Mr. Congressmen, I would like to clarify this budget. ARPA is asking for $520 million. The missile defense against the ICBM is $157 million of that. The military reconnaissance satellite is another very, very large number. If we take the balance, the percentage would be two-thirds and one-third.

What I am trying to say here is that I think a better number is one-third civilian and two-thirds military of what is left.

Mr. FULTON. Thank you.

Could I refer you to page 4, and then I am through?

Mr. FORD. Will the gentleman yield?

Mr. FULTON. Yes.

Mr. FORD. Should it not be said, if I understood your previous testimony, Mr. Johnson, in addition to the $520 million, of which you say two-thirds is for military and one-third for civilian, there is an additional sum in fiscal 1959 that would be requested, or should be requested, for the space agency on the civilian side?

Mr. JOHNSON. I would like to be allowed to answer that in this way: Congressman Fulton, with regard to the statement you made that I am running true to form in defending this agency. I have been working very closely with NACA on the assumption they will be created, this Space Agency. I have actively helped them prepare their budget. I know what the budget is that they are submitting to the Bureau of the Budget.

Mr. FULTON. What is the amount of the NACA budget that should be used for civilian space program in 1959 fiscal year?

Mr. JOHNSON. I am recommending a total of $95 million to be transferred from the ARPA budget to this new Agency. They in turn are requesting an additional amount, which I do not think they will want me to discuss here this morning. However, it is going in a

joint letter to the President that is being signed by the Secretary of Defense and by Jimmy Doolittle.

Mr. FULTON. With the chairman's permission, may we have that letter put in the record when issued? That will clear up the point.

Mr. METCALF (presiding). There is no security in the letter?

Mr. JOHNSON. We can give you a version of it that is security free. This letter is in the course of preparation now.

Mr. FULTON. Would you submit it for the record, with the chairman's permission?

Mr. JOHNSON. Yes.

Mr. METCALF. Without objection, it will be put in the record.

(The letter follows:)

ADVANCED RESEARCH PROJECTS AGENCY,
Washington, D. C., May 28, 1958.

Mr. HARNEY BOGAN, Jr.,
Assistant Counsel, House Select Committee on Astronautics and Space Exploration, New House Office Building.

DEAR MR BOGAN: The joint letter to the President from the Department of Defense and the NACA, referred to on page 2422 of the transcript, has not been issued as of this date

Sincerely yours,

L. P. GISE,
Director, Program Control and Administration.

Mr. FULTON. On page 4, at the end of the first paragraph, I am going to refer you to the limitation on the future as to space program projects. You say:

On this planning basis, our overall objective is to expedite those projects which are of immediate national importance and interest, and at the same time to project ourselves into the future as far as possible on other type research.

"As far as possible" has inherent in it a limit. The limit could be, first, time, money, ideas, facilities, personnel, or projects. What are the limits that you are referring to there? Are you limited by money? Are you limited by ideas and brains? Are you limited by the type of practical projects you want to get into?

You say "as far as possible." What is your "possible"?

Mr. JOHNSON. At the moment we are entirely limited by our ability to see ahead

Mr. FULTON. Do you not have a lot more projects you would like to be doing than you have the money for?

Mr. JOHNSON. Oh, that is always true; yes.

Mr. FULTON. Do you not have a lot more practical space projects that are really advantageous and could be followed up but we just have not gotten the country aroused to help you on?

Mr. JOHNSON. Oh, yes, sir.

For example, the 100 million-pound-thrust engine——

Mr. FULTON. You mean, 1 million-pound.

Mr. JOHNSON. Yes; excuse me

As a matter of fact, we are even taking a look at 5 million pounds. Yes; a crash program on that would enable us to spend 10 times the money we are planning to spend.

Mr. FULTON. Yes.

But when you refer to a possible death ray resulting in the future in outer space, you do not have in mind any practical program at this time to develop a death ray, do you?

Mr. JOHNSON. No.

Mr. FULTON. And there is no inference you are working on a death ray; is there?

Mr. JOHNSON. There is not. That was a hypothetical possibility I raised.

Mr. FULTON. You are not working on an antimatter program; are you?

Mr. JOHNSON. No; we are not.

Mr. FULTON. Thank you. That is all.

Mr. METCALF. Thank you. As I understand it, the other gentlemen need to go to the floor.

So the committee will be in recess now until 2:30, at which time the interrogation will proceed with the gentleman from New York.

(Whereupon, at 11:50 a. m., the select committee recessed, to reconvene at 2:30 p. m. of the same day.)

AFTERNOON SESSION

The CHAIRMAN. The committee will be in order.

Mr. Keating.

Mr. KEATING. Thank you.

Mr. Johnson, at the morning session, you discussed and put your finger on what is certainly one of the most troublesome aspects of this legislation to all of the members of this committee. And you suggested this proposed language to be substituted on page 2.

Now, taking the language which you have suggested, it would provide for the creation of this civilian agency which would have control over all aeronautical and space research, except those activities in support of or presumed to lead to the use of space for national defense in which case they would only be authorized to act if so requested by the Department of Defense. That would mean that if they were not requested by the Department of Defense they would have nothing to do with those matters.

That is your understanding; is it?

STATEMENT OF ROY W. JOHNSON, DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY, ACCOMPANIED BY REAR ADM. JOHN E. CLARK, DEPUTY DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY, DEPARTMENT OF DEFENSE—Resumed

Mr. JOHNSON. Correct.

Mr. KEATING. Now, let us assume that the Department of Defense did not request them to act in those fields. They would not act as to those activities which are presumed to lead to the use of space for national defense.

I interpret "presumed to lead" as meaning of likely use at some time for national defense; as perhaps a rough equivalent.

Mr. JOHNSON. Yes.

Mr. KEATING. Name any space activity, if you will, which would not fall in the category of being presumed to lead to the use of space for national defense.

Mr. JOHNSON. Yes; I agree. You come right to the heart of the problem.

If we presume that a man is going to go into space someday for military reasons, then everything that we learn about space has an impact on getting that man there. The cosmic-ray experiments now taking place as purely scientific for the IGY period are obviously very important.

As you read in the newspapers over the weekend, the cosmic-ray activity is far greater than scientists had expected at very high altitudes.

This knowledge, of course, is necessary if we are going to put a man up in space. We now know you have to shield him probably to a greater degree than we thought. There are many other phenomena associated with space travel that need to be investigated.

Therefore, if you assume that militarily someday it may be necessary to put a man in space then every bit of scientific data involving space has a long-term military connotation.

Mr. KEATING. And don't let me create the impression with you that this line of questioning is critical of you.

I admire you for saying what you think are the facts here and for being as helpful as you can to this committee.

But I want to get your thinking on this. Is there any area of space activity which in your judgment could not reasonably be interpreted by a person as being presumed to lead to the use of space at some time for national defense?

Mr. JOHNSON. I think that is correct.

Mr. KEATING. So that it follows from that, like night follows day, that if the Department of Defense did not request this Agency to act in any field, the Department of Defense would have the sole authority for space research?

Mr. JOHNSON. No. I think this independent agency, this civilian agency, could act on its own to cover fields of science which the military people in time sequence thought less important.

Mr. KEATING. In other words, that were not going to lead to the use of space for national defense in, let us say, the next 5 or 10 years, something of that sort.

Mr. JOHNSON. It could be. Actually I would envision a civilian agency planning for men in space as well. I would guess that the day will come when there will be transportation in space for exploration reasons, for reasons that we travel here on earth in space. And there could be parallel work going on.

Time phasing for military and civilian use might be quite different. Also the scientific fraternity may want to know about phenomena now that the military would want to know in the next several years.

Mr. KEATING. But if they were to have parallel authority, we could not, could we, word this in the way which you have suggested, that it would be in the hands of a civilian agency, except those things presumed to lead to the use of space for national defense, in which case they would only act upon request of the Department of Defense.

Wouldn't that, worded in that way, lead to the determination solely by the Department of Defense as to whether it was presumed to lead to the use of space for national defense?

Mr. JOHNSON. I think I said earlier that my attempted language here was maybe amateurish. I do not intend that in the language in the recommendation I made. I believe if that attempt is there, that ought to be modified accordingly.

I believe there should be separate activities, unrestricted activities, except for budgetary reasons.

I believe the two agencies should be encouraged to work cooperatively, to prevent duplication, which I think can be done.

My intention here was to make sure that the military problem was recognized and they could act speedily in military exploration.

Mr. KEATING. We, I am sure, share your feeling and concern regarding that. And we are grateful to you for presenting specific language. That is helpful to the committee.

But I would be worried by the use of those words "presume to lead to the use of space for national defense" unless this committee was prepared, as I doubt that it is, to leave the entire determination in the Department of Defense. And it is not your intention that this determination should rest entirely with the Department of Defense?

Mr. JOHNSON. Definitely not, sir.

Mr. KEATING. Did I understand you to say you would have this reentry problem licked in the year 1959?

Mr. JOHNSON. I think we can say so far as ballistics missiles are concerned we have the reentry problem licked now. And I would predict that in the year 1959 reentry from a satellite will be licked as well. It is not as difficult a problem as we thought a year ago.

Mr. KEATING. Well, did you mean by that reentry of the human, of a living animal?

Mr. JOHNSON. No; I meant only the reentry of a vehicle.

Mr. KEATING. When do you expect to have the problem licked of reentry of a living organism?

Mr. JOHNSON. A living organism?

Mr. KEATING. When are you going to get them up and bring them back alive?

Mr. JOHNSON. We definitely have plans to get this licked within the next 18 months—a living organism.

Mr. KEATING. Will that be a mouse?

Mr. JOHNSON. I have heard there have been some mice in experiments recently. My own reaction is that you would learn very little from animals of that kind. It seems to me that the real worthwhile experiments would be from chimpanzees.

Mr. KEATING. And there will be experiments with animals prior to human?

Mr. JOHNSON. Yes; certainly. And those experiments will be delayed until we are quite sure that the safe reentry of the animals can be made.

Mr. KEATING. You have got some volunteers of human animals but you will have to draft these other creatures.

Mr. JOHNSON. Correct, sir.

Mr. KEATING. You have made a very interesting line of demarcation which I understood to be the suggestion that the military have jurisdiction as far as the moon and the civilian space agency from there on out.

Was that an oversimplification of your suggestion?

Mr. JOHNSON. Yes, sir; I suspect it was. What I meant was that at the moment I would guess that the military would have very little reason to conduct scientific experiments in the neighborhood of Mars and Venus. The civilian agency would very definitely, I think, be interested in those experiments soon. And I would guess that we could probe Mars and Venus within the next 3 or 4 years.

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But in the meantime I think ——

Mr. KEATING. When you say "probe," do you mean in the manner in which we plan to probe the moon, by taking pictures?

Mr JOHNSON. Yes; I think that is something within the foreseeable future, but I don't believe that is a military-scientific effort in this time span. On the other hand it is entirely conceivable years from now that the interest in the area this side of the moon might be of equal concern for military reasons beyond the moon. It is a matter of timing.

This is why I feel also a civilian agency could very well complement and supplement the military work.

Mr. KEATING. Now up as far as the moon, 240,000 miles, you look upon it as primarily a military problem? Would that be a fair thing to say?

Mr. JOHNSON. I don't think that is quite fair. I think between here and the moon that there are things that the military must know more about and must have a program to know more about in order to be sure that we are not caught unawares by a scientific breakthrough or a scientific help that would produce instruments of warfare that could be used against us.

The CHAIRMAN. You don't mean that from the earth to the moon is a military area; do you?

Mr. JOHNSON No; I didn't mean that. I was trying to be very specific there.

I certainly don't. I believe there are many things we want to know about that area. But I do think that the military people must learn a lot about it too.

Mr. KEATING Well, Mr. Johnson, will you name an area of space activity between here and the moon which could not fairly be said to be presumed to lead to the use of space for national defense?

Mr. JOHNSON. I think that is right. I think that we could presume that national defense will be involved——

Mr. KEATING. In anything between here and the moon?

Mr. JOHNSON. In anything between here and the moon ultimately, yes. I sincerely believe that.

Mr. KEATING. So that under this language—and I realize that you are not wedded to it—but under the suggested language, anything between here and the moon would be governed by the Department of Defense unless they requested the civilian agency to handle it; wouldn't it?

Mr JOHNSON. No, that was not the intention. I certainly withdraw the language if that is the interpretation.

I believe that a civilian agency and the military both would have parallel paths of exploration in this area between here and the moon. I think the military obviously must have a free hand in this area.

Mr. KEATING. Perhaps instead of the words "if so requested by the Department of Defense" we should say, "If so determined by someone at a Cabinet level" or "by a Cabinet determination," or something of that kind

In other words, not leaving the matter solely in the hands of the Department of Defense. It is your contemplation that there would be areas of possible dispute which would have to be resolved by higher authority; isn't it?

Mr. JOHNSON I would agree with that; yes.

Mr. KEATING. You have been in communication with the present NACA and have been in considerable conferences about division of projects to date.

Mr. JOHNSON. Correct, sir.

Mr. KEATING. What are the natures—I don't want to ask anything I should not—but what are the natures of the projects which are in, you might say, considerable dispute between you as to who should handle it?

Mr. JOHNSON. The two basic areas that are in dispute are the man in space, which, as I pointed out, is very fundamental to the issue, and we have agreed to compromise that.

We have agreed that NACA, and the Department of Defense would have a joint program of man in space. We would fund it equally on a 50-50 basis.

The CHAIRMAN. I think that agreement is a commonsense one. I wouldn't call it a compromise. I would say that a joint program is a recognition that both were interested. And to prevent duplication and all the other things. I wouldn't call that a compromise. I would call that a commonsense decision.

Mr. KEATING. Well, it is the type of compromise preferably called commonsense decision which the members of political parties engage in in Congress from time to time.

Mr. JOHNSON. I did not use "compromise" in the negative sense. But I think it is a very sound approach.

And the other area that is in dispute is the area of a million pound or greater thrust engine where there is not now, today, a military need for an ICBM engine to give that thrust. We don't need that to go 5,000 miles, to deliver the warhead that we want to deliver. So that, too, will be a joint effort. And we are funding that on a 50-50 basis in this proposal.

Mr. KEATING. You have agreed upon it.

Mr. JOHNSON. Yes, sir.

The CHAIRMAN. What thrust is deemed necessary to deliver a continental ballistics missile 5,000 miles?

Mr. JOHNSON. Three hundred and fifty-thousand pound thrust.

The CHAIRMAN. How far have we gone now?

Can you give that information?

Don't answer any question that is classified.

Admiral CLARK. May I provide that answer to you later?

(The answer to the above question is classified.)

The CHAIRMAN. Yes.

Mr. KEATING. So that in both of these two areas which have been in dispute, you have reached an agreement with the present NACA organization.

Mr. JOHNSON. Yes, sir.

Mr. KEATING. For joint participation in these two programs?

Mr. JOHNSON. That is right, sir. And we are working together very well. The Department of Defense and the NACA has had a wonderful record for working relationships. I see no reason why the present management should not continue that kind of a relationship. We are not crticizing that. We think it is fine.

The CHAIRMAN. Of course their jurisdiction was more limited in the past than it will be under any new agency.

And that has to be considered.

Mr. JOHNSON. This is the whole problem, yes. The NACA of the past will be gone when this legislation is written.

The CHAIRMAN. The NACA was more a service agency for others.

Mr. JOHNSON. That is right, sir.

The CHAIRMAN. Now under this new agency it will not, at least in part.

Mr. JOHNSON. They will be an operating agency with power and control.

Mr. KEATING. Now there are presently, then, no major projects in dispute between you as to who should handle them.

Mr. JOHNSON. No, sir.

Mr. KEATING. And there are some which they recognize clearly as being purely military and some which you recognize as being purely civilian.

Mr. JOHNSON. That is correct, sir.

Mr. KEATING. Plus these two where you have devised the plan on divided authority.

Mr. JOHNSON. That is right, sir.

Mr. KEATING. Among those which the military has agreed are purely civilian and will be handled solely by them, could you tell us just what those are?

Mr. JOHNSON. Those that are purely civilian are a number of satellites—we will use the Jupiter—one of which will be a—well several cosmic ray experiments.

There will be one large balloon put into orbit. There will also be three lunar shots by the Air Force using a Thor-Vanguard setup, and then we are planning a follow-up program for fiscal 1959, that would involve another $45 million to $50 million of satellite launchings, the payloads of which have not been determined.

However the scientific groups would have an opportunity to recommend the next kinds of data that ought to be put into orbit to learn more about this phenomenon.

This program would really be scientific satellite launchings amounting to some $72 million or $75 million. Beyond that there would be certain work started on new kinds of instrumentation, new kinds of power sources that would be needed to travel to Venus and Mars. We need to have much more work on ion engines, for example. But placed in space they could power very large masses; get their energy from nuclear power, solar and other sources.

There is fundamental work needed for transportation in space. There is much work which can be considered right at the moment largely civilian.

Mr. KEATING. And those projects which you have just now outlined, it has been agreed between the military and the present NACA organization, would be handled by the civilian Space Agency.

Mr. JOHNSON. Yes. We are in agreement completely on the total space program. The two budgets total something over half a billion dollars for 1959. They are not approved as yet, obviously. We are in complete agreement on the total spending of that money by projects.

Mr. KEATING. That is all.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Mr. Johnson, on the projects that you have agreed to work independently on, although cooperatively, I would say—is that proper to say that?

Mr. JOHNSON. Cooperatively, yes.

Mr. McDONOUGH. There is certain basic research that is involved in the development of both of these projects, various projects?

Mr. JOHNSON. That is right, sir.

Mr. McDONOUGH. Which Agency do you look to for development of basic research on the projects that you consider military and the basic research that the civilian agency considers civilian?

I mean we should certainly come to some understanding about no duplication of basic research. Let it funnel through from one source, as much as possible.

Mr. JOHNSON. I think we have here a time problem. The basic research that a civilian agency would want now might be different from what the military would want now; depending on the objectives of that research. I think they both want the same data, but they may want it in different time periods. And this is the kind of a problem that sometimes you may not be able to resolve cooperatively.

And, therefore, each may go on his own to secure certain basic research data in a different time period.

Mr. McDONOUGH. Then if the basic research is developed and implemented by the civilian agency that will be beneficial to the military, it will be at your beck and call when you need it, and vice versa?

Mr. JOHNSON. That is right, sir.

Mr. McDONOUGH. So there would be no duplication, then, to any large degree, although probably a scientist in your group might be figuring on the same thing that a civilian scientist might be figuring on. But as far as implementation is concerned, there will be an effort to prevent duplication.

Mr. JOHNSON. That is right, sir. I think you could grasp some different concepts. Admiral Clark mentioned this morning that medicine's contribution might be very great in what we have learned in weightlessness. It may well be that certain diseases might be studied in a weightlessness concept and get some different answers.

Now, I don't think the military would be interested in that, immediately, that is, for a military objective. I am sure they are academically interested. But I mean as a military objective.

Mr. McDONOUGH. Of course that is a matter of opinion. Weightlessness, it seems to me, would be a very vital thing to the military now.

Mr. JOHNSON. Weightlessness itself is a very vital thing. But I mean in reference to studying a given disease.

Mr. McDONOUGH. Oh, I understand.

Now, insofar as the projects that are under the jurisdiction of ARPA—is X-15, one of those?

Mr. JOHNSON. No, sir; X-15 has not been considered to be an outerspace project. It gets into outer space for a few minutes at a time. That is all.

Mr. McDONOUGH. What is your understanding insofar as to which of the two agencies should spend the most time on basic research for nuclear-powered spaceships.

Mr. JOHNSON. I think there too, at the beginning nuclear-powered spaceships should be a joint effort.

Mr. McDONOUGH. That will be joint between the two agencies, plus the Atomic Energy Commission.

Mr. JOHNSON. Yes; certainly. The ion engine that I referred to is under study now in the Department of Defense in cooperation with AEC. And I suspect a civilian agency would interest itself in it.

Mr. McDONOUGH. The 350,000-pound thrust to deliver a warhead 5,000 miles, being one-third of the proposed 1-million-pound thrust, if you had 3 of those motors, you could equal a million.

Mr. JOHNSON. Yes.

Mr. McDONOUGH. It is a question of efficiency, whether it is more efficient to have 3 than 1.

Admiral CLARK. The third of a million thrust we are talking about, that third of a million is made up of three smaller engines. We do not have an engine of 350,000 pounds thrust in this country. The largest engines are the type in the Atlas missile. And these are a combination of lesser engines. I suppose you could add more. Instead of having 2, you would have 3, 4, or 5.

Mr. McDONOUGH. You would have a very big base if you did that.

Admiral CLARK. That is correct.

Mr. McDONOUGH. Is it classified as far as this testimony is concerned as to what is the maximum thrust engine we have?

Mr. JOHNSON. A single engine.

Mr. McDONOUGH. Yes.

If it is classified, don't answer it.

Admiral CLARK. I would rather provide that later, sir.

(The answer to the above question is classified.)

Mr. McDONOUGH. Very well.

Now, on the project Rover, is that part of your jurisdiction, Mr. Johnson?

Mr. JOHNSON. No; it is not, sir.

Mr. McDONOUGH. That is still a military reconnaissance project; isn't it?

It is projected for that purpose, or anticipated to be.

Mr. JOHNSON. I am sorry; it is in the Department of Defense, but it is not assigned to this Agency, ARPA.

Mr. McDONOUGH. What about Dyna-Soar?

Mr. JOHNSON. Dyna-Soar is not assigned to this Agency either.

Mr. McDONOUGH. What is in your Agency?

Mr. JOHNSON. Outer space.

Mr. McDONOUGH. Well, these are outer space projects. What do you have off the boards in the implemental stage or operational stage that would give us some idea of how far you have progressed on outer space development.

Mr. JOHNSON. The most active project is called Pied Piper. WS 117-L would be the broader connotation. That is the very large thoroughly integrated, reconnaissance satellite system, military weapons system. It is a complete concept.

It may well be man operated. But in the original concept it is not. But as we get more information on how to get a man there, I suppose it will be man operated.

Mr. McDONOUGH. How far has Pied Piper progressed?

Mr. JOHNSON. Very well. The rate of expenditure we are planning for 1959 will be triple the amount in 1958, in money and that reflects I think the progress and effort.

Mr. McDONOUGH. Well, how far has it gotten to the point where it can get off the ground?

Mr. JOHNSON. Well, test firings will start this fall. The first preliminary firings that will lead to a full-blown reconnaissance satellite being airborne. This is phased over a period of several years. The first test firings will take place this fall.

Mr. McDONOUGH. What basic thrust engine are you using on that?

Mr. JOHNSON. I think we are getting classified now. We can supply that for the record.

Mr. McDONOUGH. Mr. Johnson, I realize that you have coordinated the efforts on the missile program in your new position, comparatively new—How long have you been there now?

Mr. JOHNSON. Officially since April 1.

Mr. McDONOUGH. Yes; that is a short time. And I realize that we have a stepped-up program that we must meet in order to put ourselves in a position of competition. You may have been asked this question before.

Do you think we are moving fast enough on the program? Are you anxious to move faster?

I am speaking both of manpower under your jurisdiction and the industrial know-how in the field to build the hardware to your specification.

Mr. JOHNSON. I believe the effort we have projected in our 1959 budget is a good effort. I think we will get our money's worth. I do wish we had the money now. I could use some of it this month in letting contracts.

On the other hand I don't think we are going to lose much time by waiting until the Congress approves the budget. We are starting very rapidly with a very high caliber of scientific talent. We now have aboard some dozen men who are highly qualified in the space field, and 4 of 5 of them have doctor's degrees. We are staffing with an additional 15 to 20 scientists, and this will be complete, we think by the end of July.

Well, we will have a capability to, I think, submit in fiscal year 1960, an even better budget, with an added tempo that will encompass even greater vision in the opportunities.

Mr. McDONOUGH. You are operating on a fiscal year at the present time.

Mr. JOHNSON. Yes. You see, we are operating on the 1958 supplemental which gave us only $10 million. And that $10 million was just a downpayment on these lunar-probe shots.

Mr. McDONOUGH. Do you think you should be given the same authority on the new year budget as this bill provides for the civilian agency?

Mr. JOHNSON. Yes, sir.

Mr. McDONOUGH. Then you can move faster.

Mr. JOHNSON. That is correct, sir.

Mr. McDONOUGH. Well, as to the industrial response to your demands, are they moving fast enough?

Mr. JOHNSON. I think this is a very wonderful thing, the way industries are speculating with their own money, dreaming and thinking in outer space. I have personally listened to presentations of top men in, oh, I would guess 25 corporations who have submitted programs that literally must have cost millions of dollars to prepare out of their own funds.

I think we have, for example, on man in space over a hundred proposals, somewhere in Washington. Three or four, I think, are tremendously impressive as being realistic, as having been completely thought through. And I believe if we do get a man in space, which I hope would happen 30 months hence, it will be very importantly a contribution of American industry that got us there.

Mr. McDONOUGH. Do you have any opinion as to why, up to now, Russia hasn't done anymore than to put two satellites into orbit?

Mr. JOHNSON. I have only an opinion, which can't be verified. I think they do not have the guidance, the electronic knowledge that we have. I think they do have very definitely a thrust engine greater than ours. They were able with a single stage to put a very large object into orbit, a low orbit. I do think they intended to return the dog. I think they ran into trouble with their guidance. And I don't believe that they have solved their guidance. I feel that they must have been trying to probe the moon. I think their failure to do so by now must be guidance reasons. This is purely an unscientific opinion of a man who has only been on the job a few weeks. We know they have had failures.

Mr. McDONOUGH. You mean since the second satellite went up?

Mr. JOHNSON. Yes.

Mr. McDONOUGH. That is all.

The CHAIRMAN. Mr. Ford.

Mr. FORD. Mr. Johnson, as I analyze your testimony, it seems to me that your views indicate no desire, on the part of the military, to preempt the space field. But at the same time you don't feel a civilian agency should have the ultimate veto of any programs that the military wish to undertake in this area.

Is that a fair summary of your view?

Mr. JOHNSON. That is exactly, sir. If I could be permitted I would like to amend my testimony this morning as a result of the questioning today to make my position on a question you have asked quite clear.

Mr. FORD. Would you like to read this or would you just prefer to have it inserted in the record?

Mr. JOHNSON. I would like permission to read it.

Mr. FORD. All right.

The CHAIRMAN. You have the permission.

Mr. JOHNSON. With the indulgence of the committee I would like to make an amplifying and clarifying statement as a result of the questioning this morning.

The earnest and sincere desire of this committee to prepare legislation on space matters which will be to the maximum benefit of the United States is very clear indeed, and I want to be sure that my opinions on the subject are absolutely clear.

First, I do not presume to tell this committee how the legislation establishing NASA should be written. The purpose of my suggested rewording this morning was simply to highlight the importance of wording the bill so as not to put the Department of Defense out of business insofar as space research and exploration is concerned. I believe there should be a civilian agency for the purpose of making NACA even more effective than it has been in the past, but I do not believe that it should control or dominate space research and exploration in the United States.

Second, in the matter of NASA relations with ARPA, the discussion this morning revolved entirely around the question of what is defense research and what is civilian. While this is a knotty question, a more troublesome one has been overlooked.

Other than Vanguard, which is a low efficiency booster, the only large rockets available to launch satellites are weapons, and will be for some years.

The question then comes down not to who will conduct the experiment, but whether it should be conducted at all, since it uses up one or possibly several weapons. It means, of course, that each satellite launched must be of maximum productiveness and the experimentation to be conducted should be most carefully planned by all agencies having an interest.

It is believed in planning tests where the vehicles and money are not unlimited that considerations of contribution to national security should be paramount.

Mr. FORD. It seems to me, Mr. Johnson, that this addendum to your original statement puts this whole problem on a very practical basis. I cannot visualize any space experimentation in the foreseeable future that would not rely almost entirely upon hardware which the military has developed and is now using for its own operation. Is that correct?

Mr. JOHNSON. That is right, sir. A million-pound-thrust engine, if we put all the research of the country behind it, would probably be 5 years away, and this would be the only vehicle that could be used other than the rockets we now have.

In the meantime our own rocketry in a military sense is improving in efficiency. And to the question asked earlier, I suspect a military rocket of a million pounds thrust by combining other engines will be militarily achievable before the 5-year period. So we are faced with the civilian agency required to use military rockets to put payloads into orbit.

Mr. FORD. Assuming NASA is—it comes into being as a result of enactment of legislation by the Congress, I believe it might be well if you could put on the record how you think the 2 budgets for the 2 might be evolved; and then we can see how they would eventually come to the top of the executive branch of the Government for approval or disapproval.

Could you give us some idea how that process might work.

Mr. JOHNSON. The process is working now. We received a letter from the President, a joint letter addressed to the Secretary of Defense and to the Chairman of the Board of NACA, Dr. Doolittle, asking the two agencies to jointly get together and agree on a program, to agree on the diversion of present ARPA projects to the civilian agency when created.

And we are in the process now, as I said this morning, of transmitting a reply to this letter to the President to be signed jointly by the two agencies, giving the details of the programs of both, and the requested funding.

I think this has been a very fine piece of cooperative work. And we anticipate having—we anticipate having very little problem in getting through the executive the two budgets which will then go to the Congress.

Mr. FORD. As I understand it, ARPA's budget for fiscal 1959 is $520 million.

Mr. JOHNSON. That is right, sir.

Mr. FORD. Of which $72 million is potentially the budget for NASA?

Mr. JOHNSON. I would like to amplify that. We, in our budget, intended from the beginning that $72 million be scientific research. And this automatically would be transferred to this agency.

In addition to these cooperative programs that I have referred to, we would transfer $23 million of our money for joint programs.

Mr. FORD. Out of your proposed fiscal 1959 budget there is $72 million, plus $23 million which will be under their cognizance?

Mr. JOHNSON. That is correct, sir.

Mr. FORD. The remainder would be under ARPA's jurisdiction?

Mr. JOHNSON. Well, as I pointed out, sir, of the $520 million, $157 million is not space. The $157 million is the defense against the ICBM. So, we subtract $157 million from the $520 million, and we would get the space budget.

Mr. FORD. But then in addition, NASA will have funds of their own which it will request from the Congress separately.

Mr. JOHNSON. That is right. They have a going rate now for the work engaged in. And this submittal would request additional funds for space beyond the $72 million, or $95 million, which would be transferred from us.

Mr. FORD. There may be some concern about the possibility of duplication of effort. That can be avoided by the proper putting together of your budget and their budget and the comparison between the two at the working level.

Certainly that is what you envisage, is it not?

Mr. JOHNSON. That is right.

Mr. FORD. I can't imagine the Bureau of the Budget authorizing a budget request for the two agencies that would involve similar projects in both money requests.

Mr. JOHNSON. I think that is right.

Mr. FORD. In the early days of the Atomic Energy Commission—and I think the figures have been indicated that about 85 to 90 percent of AEC's budget was for military purposes.

Today the emphasis is going away from the military into the civilian, although still a large part of AEC's budget is military.

Would you say that under the current programs for ARPA and NASA that about the same ratio—80 or 90 percent—would be military in fiscal 1959?

Mr. JOHNSON. Well, it gets back to what is military and what is civilian. And it is so hard to draw this line.

As I said earlier, if a man in space has a military need, then everything we learn about space is knowledge that we would apply to successfully putting a man and a military vehicle in space, including cosmic ray studies.

On that concept, then everything is military.

I think this matter of definition of what is military and what is civilian is almost impossible to make.

The CHAIRMAN. Will the gentleman yield there?

Mr. FORD. Surely.

The CHAIRMAN. I suppose in answering that question that you have distinctly in mind that if we were living in a world of peace that was much easier. You are thinking in terms of the world today?

Mr. JOHNSON. That is right.

The CHAIRMAN. And the exigencies that confront us.

Mr. JOHNSON. This is my only concern. I wish, too, that this could be all civilian and the military put out of business.

Mr. FORD. The practicalities of the situation do not permit such a condition at the present time.

Mr. JOHNSON. That is right. And as I said this morning, the concern I have is that, because of our fear of the unknown, because we wish outer space not to be a military area, that we then attempt to by language or by setting up agencies to make this civilian—I don't think this will happen.

Mr. FORD. Perhaps Admiral Clark can answer this question.

From time to time in this committee, Admiral, we have had some discussion as to the rate of expenditure in new projects in research and development that eventually led into procurement of hardware.

Can you think of some project that you had cognizance of from its very inception and indicate to the committee how much was spent in the first year or so in the way of research and development and then how the buildup took place as you moved along in succeeding years?

Could you take a concrete example and give us some idea of how that process works?

Admiral CLARK. In the first 5 or 6 years the guided missile program of course, all funds expended were research and development funds.

Not until 1955 or 1956—I am talking about the Navy—did we begin to put weapons actually in the field. To put an actual percentage of dollars on it is difficult, Mr. Ford. At one particular project we had about $500 million before we got into hardware. And now it costs on the order of $25 million to buy the missiles for one ship.

Mr. FORD. How much was expended, for example, in the first year on the Polaris system? This is at the research and development stage? It was relatively small sums compared to what is being spent now? Could you give us some idea?

Admiral CLARK. I can only give you approximations. But I cannot remember the figures exactly.

The first year of Polaris, the research and development was, as I recall, on the order of $18 million. The next year it was $65 million. And this year I believe it is the order of $112 million.

Mr. FORD. I think that is a good illustration. In other words, the first year, research and development of the Polaris system was about $18 million. The second year, $65-some million. And the third year, about $112 million?

Admiral CLARK. Yes.

In this connection, if I may have a minute or so, I would like to discuss this matter of duplication.

It is in the early stages of these programs where duplication is desirable. Multiple approaches to the component question are desirable. This is your assurance of success later on.

As time goes on, you can eliminate some of the more unproductive approaches.

Where we have duplication that is bad duplication is when we have multiple weapons systems in the final system.

But to have a number of research activities working on basic activities or researching components, this is one way to assure success in a reasonable time period.

The Russians, I believe, started centralizing research and development along this line early. And it was not long before they found out that this was the wrong approach.

I believe now they have something like 700 institutions that are doing research.

Mr. Ford. That is all, Mr. Chairman.

The Chairman. I have been studying this proposed amendment that you have suggested. You indicated in response to questions that I asked earlier in the morning that in support of the use of space for national defense—I will leave out the words "are presumed"—but that is broader than the words used in the bill—"primarily associated with weapons systems or military operations".

Mr. Johnson. That is the intent—to make it broader, yes, sir.

The Chairman. The reason for that is that there may be activities in connection with the national defense other than—important and vital as they are—weapons systems or military operations.

Mr. Johnson. It is very late in a research program that you can visualize a weapons system. Once you visualize a weapons system, it is no longer research. My plea is that the Department of Defense be permitted research in these areas as they are permitted research in other areas that may have a military-science implication.

The Chairman. In other words, it is felt that in the world of today it is better to use the broader language than to use language that might be construed as covering a more limited field and really constitutes national defense?

Mr. Johnson. That is right, sir.

The Chairman. Now, it says "or presumed." I realize it is hard and difficult for you to give a definition of the word "presumed" as used in the amendment. But "presumed" might be just a person's opinion or thoughts.

Now, a determination is different from a presumption. "In support of" or "that is determined will lead to the use of space." There is a determination there by either the Director, the new Director, yourself, or the Secretary of Defense; in other words, there has got to be a determination.

Now "in support of" is one thing. Or "presumed" or "that is determined that it will lead to the use of space for national defense"—of course, the words "for national defense" are words of limitation and direction. We understand that.

Mr. Johnson. I think the basic problem there is that it would be almost impossible to determine in advance. Again a matter of judgment will always be involved in this area. I would rather err on the side of judgment that was incorrect occasionally but make sure that no opportunity was overlooked for defensive reasons than to restrict that language to a determination. Because if that determination was made outside of the Department of Defense without all the knowledge that the Defense Department has, it might be the wrong determination.

The Chairman. Of course, my question presupposes that that determination under this language would be made in the Department of Defense.

Mr. JOHNSON. Oh, then I would have no objection whatsoever; yes, sir.

The CHAIRMAN. Because it says "insofar as such activities may be in support of or presumed to lead to the use of space for national defense."

So that determination would be made, it would seem to me, in the Department of Defense.

Mr. JOHNSON. Well, if one made that assumption, then I think the language would be fine.

The CHAIRMAN. I am not saying that I—I am just exploring for the consideration of the committee later when we get into executive session. Because we have problems, as you know, beyond this committee.

Mr. JOHNSON. I understand, sir.

The CHAIRMAN. When we report a bill in the House, somebody will ask me what does "presume" mean. I have a lot of difficulty answering that. It leaves us more or less in the field of speculation.

And the committee would be vulnerable to attack. And "that is determined"—those words are plain. I assume by the word "presumed" that is what you mean—that is determined. Because that word "presumed" is not connected with "in support of."

"In support of" is one thing; "that will lead to the use of space" or "presumed to lead" is another thing.

Mr. JOHNSON. I agree with you.

Your connotation is correct. This would be self-serving; that the Department of Defense would so determine. That is correct, sir.

The CHAIRMAN. Then if the committee should in its wisdom—and I am not saying that I would be for it—I am just exploring—yet, I recognize the importance of the military in the world of today. And you say if we are going to err in judgment; I would go further, and say that if I am going to err in judgment I would rather err on the side of strength than weakness.

I have said that repeatedly before the House. We have to be prepared at all times, and be overprepared if we can be. But we won't go into that now.

We have to project our minds and see that this has to go through both branches of Congress. We have to come out of here with a civilian committee. And yet at the same time we have to recognize the practical situation that confronts the world of today and the word "presumed" if any member should hit upon that, why, I could imagine there would be a lot of difficulty for the members of the committee, including myself, answering that adequately where the word "determined" is used, or "decision made" or anything like that.

If we connect it up where there would be a few areas of disagreement, and it could go to the President or someone designated by him, why, nobody could object to that, that I could see.

Mr. JOHNSON. Admiral Clark and I both agree that "determine" is a better word.

The CHAIRMAN. Let me ask this of both of you gentlemen. We cannot write into a law words to meet every detail. We know that.

You have made a very fine case on something that might happen from hour to hour. What do you think of the liaison committee between this new Space Agency and the Defense and the Atomic Energy Commission where they are on a working level and they meet and they know what is going on?

Each one should acquaint the other with as much information as possible to prevent duplication of efforts and work. We expect a team. That is at least what I have in mind.

What might happen 10 years from now is another proposition. We will probably have a more peaceful world. But in the world of today we have to have the military in its proper sphere. We will not have a country, in case of war, unless we win.

What would you think of a liaison committee, sort of a working committee, that could meet as frequently as they wanted when anything arose, like in the Atomic Energy Commission.

Mr. JOHNSON. We like your idea of working very closely with the Congress. I think that bill has some safety features that are very desirable.

But there is the possibility of official committees set up by law delaying decision making. And do you want to comment on that, Admiral Clark?

Admiral CLARK. I think two different subjects are being discussed here. You were speaking, Mr. Chairman, were you not, of a committee such as our Military Liaison Committee with the AEC. That is the sort of thing you are talking about?

The CHAIRMAN. Something along that line; yes.

Admiral CLARK. Yes.

Mr. JOHNSON Oh, by all means; I like that idea.

Admiral CLARK. Yes; we feel that such a committee must be in existence We do not think that it needs to be, or should be, written into the law. As we said in this—as Mr. Johnson said in his amplified statement, the number of satellites that will be necessary to do all the exploration that we want will become quite a large number, Mr. Chairman. And these will come from the Nation's stockpile of weapons. And every one that is fired must be worked out completely to give us everything that it can.

Now, whenever a satellite is fired, we would sit right down with the NASA, with the National Science Foundation, with the National Academy of Sciences, and say, "We have a satellite here we are going to fire, what should we put in it; what should this experiment be?"

It should be a well-planned experiment to augment past knowledge, penetrate the frontiers of new knowledge, and not duplicate past work. In other words, it should be a well-planned experiment by everybody who has an interest in it.

The Department of Defense does not necessarily want the right to determine who is going to do what or determine what it should do. The Department of Defense's concern is simply that the Department of Defense not be written out of space exploration by law.

The CHAIRMAN. What do you mean by "written out"? You are not written out by this bill?

Admiral CLARK As I said this morning, the wording says that the Department of Defense will have projects that are associated with a weapons system or a military operation; that would immediately put a damper on our basic research, on our advanced research, in the fields leading up to these things, that we cannot visualize. We do not know what they are.

The CHAIRMAN. We had that in mind, Admiral. It was called to our attention by some of the previous witnesses. We had in mind some other language, including research and development, or words

to that effect. That was in mind and put before the committee. But you think your language in the proposed amendment will be better and cover the whole thing?

Admiral CLARK. With your modification. When you say "determined" is a better word, we agree.

The CHAIRMAN. Go ahead. I didn't mean to interrupt you, Admiral.

Admiral CLARK. I had finished.

The CHAIRMAN. But you think a liaison committee would be very helpful on a working level?

Admiral CLARK. It would, and I think there isn't any question but that this will be established. It is now, informally.

The CHAIRMAN. I would think, from the angle of the Department of Defense—and I would feel happier if I knew there were specific provisions for it. Then I would know the military are keeping in touch.

Admiral CLARK. Well, if you are speaking of a committee that would, in effect, provide a communications system, this we will have to do whether it is in the law or not. We could not work without it. Now, if you are talking about a committee that would have the authority to say who is going to do what, then that is something else. But I understood you to say on the working level. And that we would have to do. We just couldn't do without it.

The CHAIRMAN. It was on the working level that I had in mind. We have the Board, haven't we—the Advisory Board? It says, "At least one member shall be from the Defense Department." I am not talking about that. I am talking about the relationship with the Defense Department from day to day, keeping in touch with one another on the working level.

Admiral CLARK. Yes. And each will be very sure he knows what the other one is doing.

Mr. KEATING. You do not feel that you need, for that purpose, anything in the legislation at all? That would be an essential part of any working arrangement?

Admiral CLARK. Yes, sir.

Mr. MCDONOUGH. Is there, at the present time, a natural channel of exchange of information between NACA and the—and ARPA? Is there such an exchange of views in basic research at the present time?

Admiral CLARK. Yes, sir; almost continually. It is on an informal basis.

Mr. MCDONOUGH. Then it is a very natural thing. It does not require legislation, because it is a natural desire on the part of ARPA to say, "We have studied basic research on this particular physical implementation of something in space technology," and NACA says, "The same to you."

I notice in Mr. Johnson's statement that he refers to NSF, NAS, NASA, ARPA, and others deemed appropriate under the guidance and overall direction of the present Scientific Advisory Committee.

So, that means that there is a perfect coordination there, and the reason I wanted to emphasize and to be assured there would be no duplication on basic research is because basic research usually takes a long time and costs a lot of money. And, if a formula is found to work in the civilian agency and it is good for the military, they

should immediately report it to them. And if the military finds something—if the military finds a formula that is good to work in the other group, they should immediately report it to them.

Now, as far as building the hardware is concerned, there you get into expenditure of money in the industrial field. And it depends on, then, the ultimate use of the project for military or civilian and which of the two should write the specifications and call for the bids. Isn't that true?

Mr. JOHNSON. That is right, sir. And, of course, the problem with regard to all missiles—there are two demands for them. We do want to establish missiles bases, and missiles are wanted to fire satellites. There has to be a thoughtful program of timing, so that both can be done without impairing the work of either.

Mr. McDONOUGH. Yes. Well, I have appreciated over the years the competitive spirit between the various military branches. I have also been a little disturbed about the attempt on the part of one branch to do a better job than the other and, thereby, duplicating and overlapping many of the functions of one branch of the military service to the other.

I think we ought to get away from that kind of overlapping desire to be better than the other fellow. They ought to put the thing—they ought to sit around the table and talk it over a little bit, rather than to compete as severely as they have.

In many cases, duplicate airfields, duplicate types of aircraft, duplicate types of missiles, each one of them claiming they won the war. Who is going to deny it? They were there and shot the shots.

The CHAIRMAN. That is pretty good argument for the President's reorganization plan.

Mr. McDONOUGH. It is in that direction.

Mr. JOHNSON. This is one of the reasons for ARPA being set up; to get the conflict in space and missile defense out of the competitiveness of the three services. We are valiantly trying to do this. And one example is this: Just Friday we had the meteorological people from the three services, including the Weather Bureau, together, and we said, "Now, what do we want to do on space satellites to improve weather forecasting? Are each of you four going to set up your own satellites and go your own way?" The Lord forbid. And we talked this out.

And I suspect, as a result of this continuing meeting that will go on now between the four agencies, that we will have a program—it will not suit everybody—but we will have weather reporting via satellites that will satisfy the civilian, the Weather Bureau, it will satisfy the Navy, the Army, and the Air Force.

Mr. KEATING. Who is going to get it?

Mr. JOHNSON. ARPA.

Mr. KEATING. No. But which one of the services is going to do it?

Mr. JOHNSON. ARPA will determine that, depending upon the best boosters, the best equipment to get the satellite up there.

The CHAIRMAN. That is all right, within the Agency. You are dealing with two agencies now—one the Defense Department, and the other the new Space Agency. I will agree with you that ordinary common sense should say such a committee should be appointed. But, on the other hand, we meet stubborn-minded men in the journey of life. And, if everybody agreed there should be a liaison committee, why not specifically provide for it in the law? Then it has to be.

Mr. JOHNSON. I agree with you, sir.

The CHAIRMAN. That is all I have.

Mr. FELDMAN.

Mr. FELDMAN. Mr. Johnson, in response to a previous question, you said that—I think it was you, Admiral Clark, who said that, in order to get a ballistics missile that would travel 5,000 miles, you would have to have about a third of a million pounds of thrust.

The engine that the Russians developed in connection with the 2 sputniks, I am told, had, conservatively, between 250,000 and 395,000 pounds of thrust. And one estimate from another military source was that it had approximately 500,000 pounds of thrust.

Does that mean the Russians have a ballistic missile that can travel 5,000 miles?

Admiral CLARK. Yes; I would think they had an ICBM that could travel 5,000 miles. We have the thrust necessary for this. But we do it by combining engines. Some airplanes are 4-engine, some 2; it depends on the model; we put them together.

Mr. FELDMAN. If we have such an engine, why don't we get something up that weighs 1,100 pounds?

Admiral CLARK. I said we cluster our instruments.

Mr. JOHNSON. Sir, we have plans of getting something up that weighs more than 1,100 pounds in the not too distant future.

Mr. FELDMAN. It is one thing to plan something and another thing to get it up there.

Admiral CLARK. I would remind you that right after Sputnik I—immediately after Sputnik I, Russia promised the world a satellite a month. They haven't quite made it.

Mr. FELDMAN. Is that an official pronouncement?

Admiral CLARK. It was in the press. They announced it, officially.

Mr. FELDMAN. I am glad to hear they are not succeeding. And I hope you are right.

Admiral CLARK. They fired a much larger one than we have.

Mr. FELDMAN. You have worked closely with the NACA; is that right, Mr. Johnson?

Mr. JOHNSON. That is right, sir.

Mr. FELDMAN. NACA has a number of committees?

Mr. JOHNSON. When I say I have worked closely with NACA, I mean it has been only in the weeks I have been working with this particular project. As far as NACA, my work does not go for any long period of time. I am not completely familiar with their committee operations.

Mr. FELDMAN. Well, I am told they have five major committees. They had four until last fall. And then they created a new one in connection with space. And they have 31 subcommittees. And then they also have some panels under the subcommittees that meet on occasions.

I am told, also, that when a project is presented to NACA it starts with either one of the panels or with one of the subcommittees and then has to go through the organization before it finally gets up on top.

Do you know the timelag involved between the time that a project is first presented to NACA and a final decision is reached?

Mr. JOHNSON. No; I do not, sir. But I would guess, from using the committee-type structure, that it is quite a while. This is generally the case.

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Mr. FELDMAN. Now, going through these liaison committees, and a decision is finally made by the Director, if the project were one that is in controversy as to whether or not it was civilian or military in character, and there was an impasse reached, then the matter would have to be presented to the President, or a person designated by the President?

Mr. JOHNSON. That is my interpretation; yes.

Mr. FELDMAN. Now, that person, in order to be able to make an appraisal of the project, would have to study it very carefully?

Mr. JOHNSON. He would have to go through the whole procedure again: yes.

Mr. FELDMAN. That is right. He could not be enough of an expert so that, if the problem, say, involved cosmic rays, or some other highly technical problem, even though he, himself, were a scientist, he could know it all. So he would have to, in turn, have a staff which would be advising him concerning these various projects: is that not so?

Mr. JOHNSON. Certainly. If I were in that position, I would demand a staff.

Mr. FELDMAN. So what we have is another agency on top of this Agency; is that not so?

Mr. JOHNSON. Well, you would have a staff on a staff on a staff; yes. It may not be an agency.

Mr. FELDMAN. Well, it is still an agency. Whether you call it a staff or agency is immaterial.

What I am trying to get at is this: Dr. Dornberger, who is one of the elder statesmen in this field, testified here on Thursday. And he said he began in 1951 and made 678 separate and distinct presentations—separate presentations—of a project which was finally accepted in 1958.

Is this the result of this kind of layer upon layer of committee and indecision which results in that kind of a delay, and the huge amount of effort involved in getting an answer?

Mr. JOHNSON. It could be. I wouldn't know how to answer that question in this specific case. But it could be.

The CHAIRMAN. Are you familiar with the report last October of the Army scientists, the panel, Secretary Brucker's report that we have the men, the facilities, but the question is top management?

Mr. JOHNSON. No, I am not familiar with that report, sir.

The CHAIRMAN. That is in the record.

Mr. FELDMAN. Do you feel that the Department of Defense should be allowed to carry out any space projects it feels are military in character, even if they had foreign policy implications which might be important to the Department of State?

Mr. JOHNSON. Oh, no, sir. I think the National Security Council—there definitely are connotations that have to be weighed by the President and the entire National Security Council involving the Department of State and other agencies. I would not think that the Department of Defense could be freewheeling ever.

Admiral CLARK. We are briefing the Department of State tomorrow morning on a number of our projects for their education in space work, programs to be planned, and things we want to do for this very purpose.

Mr. FELDMAN. Do you feel the head of this Agency, this new Agency, should be a member of the Security Council?

Mr. JOHNSON. Are you referring to the new civilian Space Agency?

Mr. FELDMAN. That is right.

Mr. JOHNSON. Well, I think that there would be good reasons for it. And I can think of reasons against it. Because policymaking at that level cannot involve too many people, too many agencies and too many viewpoints.

I think the reporting should be made to the President; someone in the President's office would probably make the Security Council familiar with the viewpoint if there was a viewpoint there to be expressed.

We would not recommend officially making them a member of the Council, no.

Mr. FELDMAN. Getting back again to this committee structure where you have, as I say, starting with a panel, a subcommittee, then a committee, then the Director or a Commissioner if you will, and then going to—having to go to the designee of the President or the Agency or the staff that would be appointed to arbitrate disputes; do you think we can afford to sit on our hands that long and wait for a decision on some important project while the Russians, of course, are going full speed ahead?

Mr. JOHNSON. No. This is really my concern. I can see in the months ahead very important decisions being made day to day.

If this were not a public hearing we could take our hair down and tell you of some decisions that are being made by the hour right now fraught with tremendous responsibility.

We are going off on a project decided in the last few days that has a 15-percent chance of succeeding. But it is so imperative to find this knowledge that we had to do some very extraordinary things even over the weekend. If I had had to stop and get a committee or someone else into the act, we would have lost very precious hours. And this is a matter of utmost urgency.

And I think more of this is going to come in the future.

Mr. FELDMAN. That is why ARPA was created?

Mr. JOHNSON. We have cut red tape and we deal directly.

Mr. FELDMAN. Which of the following projects would you feel should be controlled by ARPA and which by NASA if it is created:

1. Weather reconnaissance satellites?

Mr. JOHNSON. Weather reconnaissance has very vital connotations. Any military theater needs to have the weather forecast much more accurately than we do now. The Navy has different requirements than the Air Force. The Air Force has quite a different problem. And the Army has an entirely different one.

Now, the Weather Bureau has another problem. My guess is that to best do this job, since much military equipment will be used, that it ought to be under the supervision of a military agency.

However, I would not argue in putting it under a civilian. But my guess would be that if that were done, instead of having a minimum number of weather satellites in orbit, we might have to put a—and expensively—put up additional ones to satisfy additional military and civilians separately.

Mr. FELDMAN. No. 2. Television, facsimile relay satellite.

Mr. JOHNSON. Television could be used, of course, for cloud cover to tell us what cloud formations there were.

It could be used also for reconnaissance of another nature. I think, generally speaking, the weather reconnaissance will ultimately use television. Television is accurate—or television can accurately tell in a small area whether the clouds are rising or falling, which will be very helpful information.

I would say television would definitely be needed in military reconnaissance and will be needed also for weather observation.

Mr. FELDMAN. Three. Mapping satellites.

Mr. JOHNSON. Mapping satellites, of course, obviously have two uses. And my guess is that the greater use for the period ahead will be military. We know more about our own country than we know about other countries.

Mr. FELDMAN. Four. Manned space station. Or a large satellite.

Mr. JOHNSON. Well, I cannot conceive of a civilian need to put a man in a satellite at the moment. But I can conceive of many reasons militarily. I think this is a military program; should be a military program.

It is going to be a very expensive one. It is going to be very, very costly to put a man up there and keep him there for any period of time and do it with any assurance of success. Millions and millions and millions of dollars.

If we are going to do it through a civilian agency, it is hard to justify it.

Mr. FELDMAN. Five. Probes to the Moon, Mars, and Venus.

Mr. JOHNSON. I think we have already made that decision. For now we are conducting the scientific experiments but will transfer them to the civilian agency.

Mr. FELDMAN. Six. Manned circumlunar flight.

Mr. JOHNSON. For the moment that is also civilian.

Mr. FELDMAN. Seven. Manned round trips to the moon or planets?

Mr. JOHNSON. There I think you are coming very close. If you are operational to that, the military has got to get into the act.

Mr. FELDMAN. Eight. I have here a million pound rocket. But you answered that question before.

Nine. Nuclear rocket system.

Mr. JOHNSON. The military are just as interested in nuclear rocket systems as any possible use in a civilian setup.

Mr. FELDMAN. Ten. The Ionic rocket system.

Mr. JOHNSON. Same for that.

Mr. FELDMAN. What are the real principles that have guided these decisions that have long had ultimate military applications as well as civilian and scientific uses?

Mr. JOHNSON. We have used, I think, a formula—not an original one—but again I come back to the time span. At the moment this first basic knowledge that we are getting is purely research in character. We are saying it should be under civilian auspices, because the whole scientific fraternity is interesting themselves. The IGY program let loose a whole—literally hundreds of scientific people in the search for new data.

We want to keep that enthusiasm and that interest high. I believe that the continuation of the IGY program, which I understand has been extended for another 6 months, is a very desirable thing.

I think that sort of thing under a civilian agency ought to go on for a number of years.

Then, as this science becomes more definitive and we see the military threat—I think that is what we always have to look for—by using that science, then I think we have to do more in the Department of Defense down very special alleys. And I could talk—if this were not an open session, I could talk also about security matters and things we are learning already that very early have military problems.

Mr. FELDMAN. I think it gets back to something along the line that Congressman Ford mentioned before, namely, that there has to be a transition period. While the percentage of military activity may be great at the outset, it becomes lessened over the years, just as in the case of the Atomic Energy Commission where the development of isotopes is becoming an important factor as well as nuclear reactors for powerplants and things of that sort.

Experience teaches those things. And then, as I say, the peaceful uses become—the percentage of peaceful uses increases correspondingly.

Mr. JOHNSON. It is bound to do that here also.

Mr. FELDMAN. At least at this point, the NACA as presently constituted works primarily either for the military, that is, serves the military, or contracts with the military; is that not so?

Mr. JOHNSON. Yes, sir, it does. But the charter that set the NACA up allows that Agency to initiate work on its own.

Mr. FELDMAN. Well, I am talking about the fact, rather than what the charter says.

Mr. JOHNSON. Oh, yes, as a fact I think you are right.

Mr. FELDMAN. No further questions.

The CHAIRMAN. What kind of a man—the qualifications and so forth assuming it is an Agency with a director or an administrator—oneman agency—what kind of man do you think should head the new Agency at this time?

Mr. JOHNSON. Well, certainly he would have to be a very highly qualified man. I would say that his administrative ability should transcend other characteristics. I do not necessarily think that it would be necessary or even wise to pick the finest scientist, for example that we have in the country and put him in charge of a show like this. I think that the man has to be administratively capable with a proven record for getting things done, of planning—the planning function, particularly.

I think he has to have an understanding, however, of research and scientists in order to work with them. I think the greatest characteristic is a proven record of getting things done—cooperatively, of course, and preferably within Government.

The CHAIRMAN. Well, proven records in one situation might create a status quo state of mind as to the future, you understand.

Mr. JOHNSON. Yes.

The CHAIRMAN. Would you include in that that one must have a forward-looking, pioneering mind, and a sound refreshing dynamic outlook?

Mr. JOHNSON. Oh, you describe perfectly the other characteristics that are certainly needed.

If a man doesn't have vision and is not reaching forward all the time, he won't work. I think he ought to not be interested in operational hardware as such.

The CHAIRMAN. We could pass the best law in the world, and if it isn't administered right, why, then, it is a poor law. A law that may not be weak and may not be strong, but has flexible provisions and interpretations—with a man who has confidence in himself, it could function fairly well.

So, no matter what we do, it has to be administered through human hands. That is a question that is self-answerable.

Mr. JOHNSON. However, sir, if I may observe this: Counsel was talking about committees and panels and administrative procedure that is time-consuming. I think it is important to recognize an experience perhaps that gets things done quickly but thoroughly. This is the reason I put the emphasis on administration first.

The CHAIRMAN. I realize the significance of that. Because I understand administrators in this particular field are very few and far between. They don't necessarily have to be scientists, but have the confidence.

I understand Doctor Killian is one of those men.

Mr. JOHNSON. I think he is a very capable man.

The CHAIRMAN. We understand just what you mean, Mr. Johnson.

Mr. JOHNSON. The Chief Scientist for ARPA is in the same league. He is largely responsible for our atomic weapons—as much responsible for our atomic weapons as any man in the country.

The CHAIRMAN. I found when we had the Riehlman Committee in 1954 there were good men, fine men, dedicated men, men I respected, but there were those little clashes of personality which we all have which we have got to subordinate to the country's interest.

I attach much importance to who is going to be appointed if we establish an agency with one man at the head. Because we can pass the strongest law in the world, but it isn't going to be administered effectively unless there is a man there who has the vision and the capabilities and all the other factors that will make up—and most important among those is confidence in himself—I would rather have a man with ordinary ability but good commonsense than a brilliant man who is irrational-minded, for example, in a position of trust.

And, so, it is very important what kind of a man is appointed in the event of a one-man agency.

Are there any further questions?

(No response.)

The CHAIRMAN. You have been very patient, both of you gentlemen. And we appreciate it very much. You have given us an awful lot of information. You have been frank.

And for myself, as chairman of the committee, and for all the other members of the committee, I express to both of you gentlemen our thanks.

Mr. JOHNSON. Thank you. It has been an honor to be here.

The CHAIRMAN. The next witness is Dr. Hubertus Strughold, Chief of the Department of Space Medicine, School of Aviation Medicine, United States Air Force, Randolph Air Force Base, San Antonio, Tex. And also Col John Stapp, Chief of the Aero Medical Laboratory, Dayton, Ohio.

Have you a prepared statement?

Dr. STRUGHOLD. Yes.

The CHAIRMAN. Do you have one, Colonel Stapp?

Colonel STAPP. I have a fairly large report to come later.

The CHAIRMAN. Well, we will hear Dr. Strughold and then you can make your preliminary statement. Then we will have members of the committee ask both of you questions.

We are glad to have you before us.

Mr. KEATING. Do we have copies of the statement?

Dr. STRUGHOLD. They are available.

The CHAIRMAN. All right. Dr. Strughold.

STATEMENT OF HUBERTUS STRUGHOLD, M.D., Ph.D.,[33] PROFESSOR OF SPACE MEDICINE, ADVISER FOR RESEARCH SCHOOL OF AVIATION MEDICINE, UNITED STATES AIR FORCE, RANDOLPH AIR FORCE BASE, SAN ANTONIO, TEX.

Dr. STRUGHOLD. I consider it a great honor to appear before this committee today (May 5, 1958) to discuss the medical aspects of space flight, or astronautics. Perhaps first I should give you in a brief prepared statement an overall picture of this entire field of space medicine and astrobiology, followed by specific remarks about the following points:

1. Medical and biological research aspects of space exploration.
   (*a*) What research is being done.
   (*b*) What are the areas which need immediate and special attention?
   (*c*) How can research be improved.
2. Education in the medical and biological sector of astronautics.
   (*a*) What is the present status.
   (*b*) How can education be improved.

Scope of research.

As a logical extension of aviation medicine, space medicine studies [35] the medical problems in flight within the space-equivalent regions of the atmosphere, and [36] outside the aerodynamically effective atmosphere. They are essentially the result of the ecological milieu conditions of space and of the process of motion to, through, and return from the environment of space.

The inclusion of the environment found on other celestial bodies into space medical considerations, i. e., viewed from the standpoint of human physiology and survival requires careful studies in planetary ecology in advance. This astromedical study overlaps with astrobiology which concentrates upon the question of indigenous life on other celestial bodies. All these various studies represent specific aspects of a more general field which can be called bioastronautics.

Originating about 10 years ago, space medicine has made considerable progress in the United States theoretically and experimentally

[33] Strughold, Hubertus, physician, educator, b. Westtnennen, Germany, June 15, 1898; s. Ferdinand and Anna (Tillmann) S., student U of Muenster, 1919–20, U. Gottingen, 1920–21, U. Munich, May–Oct. 1921, Wurzburg and Muenster, 1921–23, degrees· Ph.D , M D , unmarried. Asso. prof physiology, U Würzberg, 1932–35, U Berlin, 1935–45; dir. Aeromedical Research Inst. at Berlin, 1935-45, dir. The Physiol. Inst., U. Heidelberg, 1947–49, prof aviation medicine, U S. Air Force Air Univ., Maxwell Air Force Base, Ala., 1949; chief dept. space medicine, U. S. Air Force Sch. Aviation Medicine, Randolph Field, Tex , since 1949. Sec., biographer, Space Med. Assn., of Am. Aeromed. Assn., 1951–52. Author· Grundrisseder Luftfahrtmedixin; Space Medicine (coauthor). Contbr. articles on physiology, aviation medicine and space medicine. Address· U. S. Air Force School of Aviation Medicine, Randolph Field, Tex.

[35] Atmospheric range from about 12 to 120 miles.

[36] Atmospheric range from above 120 miles.

in the laboratory and in flight operations. In the U. S. S. R. the literature in "cosmic medicine," as space medicine is called, follows very closely the line of thinking of the West. For several years the Russians have stood on their own feet, and the progress made by them is evidenced by animal experiments in rockets, and by Sputnik II. In 1947 the Russians founded a department of astrobotany.

After this brief introduction, the following comments are made.

1. MEDICAL AND BIOLOGICAL ASPECTS OF SPACE EXPLORATIONS

(*a*) What research is being done? A great deal of research has been devoted to human engineering of the space cabin as carried out in space cabin simulators. These studies concentrate upon the question of the best suitable artificial atmosphere, and of the most effective air regenerating devices.

Methods for recording the climatic conditions in such closed ecological systems and for recording the physiological reactions are being developed. For the past 5 years the inclusion of plants in a closed ecological system as oxygen producers and carbon dioxide absorbers has been under study at various places. The effect of increased g. forces upon the human body is pretty well understood due to studies on centrifuges and on sleds. Zero gravity, or weightlessness, is presently being studied during parabolic flights in jet planes concerning its physiological and psychological effects

The problem of day-night cycling in space operations has been and is being studied theoretically and experimentally in space cabin simulators. The same is true for the psychological effects of isolation and confinement.

Sealed gondolas have been tested in manned balloon flights up to 102,000 feet. One man has been kept alert in a space cabin simulator for 7 days.

The physiological effect of rapid decompression of a space cabin is well understood. Cosmic ray studies have been carried out in numerous balloon flights. In experimental astrobiology, terrestrial microorganisms have been studied under simulated Mars conditions. These are some of the most important studies that are underway.

(*b*) What are the areas that need immediate attention:

(1) Methods of rescue during the critical launching period.

(2) The problems related to reentry.

(3) Studies concerning long range straight line landing maneuvers.

(4) Visibility of the earth from great altitudes.

(5) Exposure to gravity for longer durations.

(6) Exposure to cosmic rays for longer periods of time.

(7) Simulation of cosmic ray particles.

(8) Experimentation with artificial meteorites and their impact upon a closed cabin.

(9) Search for the most effective air-regenerating means.

(10) Continuation of efforts in the development of comfortable pressure suits.

(11) Animal experiments in rockets and satellites as supporting studies for the solution of manned space operations.

(12) Interdynamic medical adaptation to space flight for selection.
(13) Experiments in multimen space cabin simulators.
(14) Telemetering as means of monitoring the space crew.
(15) All medical problems related to the time factor in flight.
(*c*) How can research be improved?
(1) By minimization of redtape.
(2) By more and better facilities.
(3) By better opportunities in the form of a sabbatical leave for scientists to visit scientific institutions here and especially abroad.
(4) By the creation of a translation and distribution center of foreign literature.
(5) By the introduction of the metric system. (The introduction of the metric system by the Russians during the October Revolution of 1917 is to a great extent responsible for their success in rocketry.)

2. EDUCATION IN THE MEDICAL AND BIOLOGICAL SECTOR OF ASTRONAUTICS

(*a*) What is the present status? For more than 5 years, space medicine has been taught in the various courses for flight surgeons at the School of Aviation Medicine, Randolph Air Force Base, Texas only.

(*b*) How can education be improved? All universities should include in their curricula several space medicine lectures per semester. Educational films should be used on a broader scale.

All pupils in grammar schools and students in high schools should be familiarized immediately with the metric system as this is the only system that—as in nuclear physics—can conveniently be used in astronautics.

In concluding this report, I should like to emphasize that all the efforts at the present time have to be concentrated on achieving a manned orbital flight in the sense of celestial mechanics. A dozen or so revolutions of such a biosatellite will reveal whether or not man can stand space flights over longer periods of time. At present it seems to me that, from the standpoint of medicine, the picture looks rosier than it did 5 years ago, but it should also be emphasized that there are limitations for space operations in our solar system. Space flight in the near and remote future will have to be confined to a certain area in our solar system. (Ecosphere=the range from Venus to Mars.)

All suggestions for operations beyond this area are not acceptable from the standpoint of space medicine and belong in the department of nonsense. For a realistic approach, factual science combined with imagination and horsesense must be the basis for planning in the exploration of space.

As a final remark I would like to add that space medical studies will be beneficial for medicine in general.

Thank you very much.

The CHAIRMAN. Colonel, do you want to make your statement now?

Colonel STAPP. Yes, sir.

STATEMENT OF COL. JOHN PAUL STAPP,[34] CHIEF AERO MEDICAL LABORATORY

Colonel Stapp. My principal concern relates to the rather limited resources for biomedical research which exists in the United States. These are concentrated in 3 aero medical laboratories in the Air Force and 2 facilities in the Navy. The Aero Medical Laboratory at Wright Field, the School of Aviation Medicine at Randolph Air Force Base, and the Holloman Air Force Base Aeromedical Field Laboratory. In the Navy, Aero Medical Acceleration Laboratory at Johnsville, Pa., and location of a modern human centrifuge, and at the Pensacola activity of the Navy in conjunction with the Navy's flight surgeon school, where cosmic radiation biological effects are studied.

This means that we have in these laboratories facilities that have been developed, special equipment for aero medical and space medical research, and a limited number of personnel that can be used effectivey in carrying out such research.

A report which I would like to have admitted to the record for later delivery concerns the resources for biomedical research available in the Armed Forces, and in particular, the Aeromedical Laboratory and the supporting laboratories at Wright Field, which constitute a very strong capability. A civilian agency requiring space medical and aero medical research would have the choice of working with these facilities without disturbing or greatly impairing their capability, or else creating laboratories of its own which could only be staffed adequately, at least in the early stages, by competing for the services or personnel in the armed service laboratories, or else by utilizing a contractor who would have no choice except to proselyte the armed services laboratories personnel

Speaking as the project officer for Wright Field's man-in-space program, we are very happy to cooperate with the civilian agency in carrying out any research problems in the area of human factors in relation to space research. In my own career I have done both civilian and military research; I find the only difference to be in the applications. The capabilities can be turned in either direction; if the military laboratories were to be limited specifically to military missions, then, a large proportion of their capability would certainly be available for work with a civilian agency on whatever problems could be agreed on.

I can see only three important military potentialities of a man in space that need exploration. First, is the capability of a man to be of any use in a boost glide or Dynasoar type of vehicle. Here it is intended to use a man in a ballistics missile for whatever guidance he can adequately provide.

(The above-mentioned report follows:)

[34] Stapp, Dr John Paul, Aero Medical Field Laboratory, Holloman Air Force Base, N. Mex. Biophysics Bahia, Brazil, July 11, 10, m 40 B A, Baylor, 31, M A, 32, Ph D (biophysics), Texas, 40; B M and M. D, Minnesota, 44. Instr zool, Decatur Col, 32-34, teaching fellow, Minnesota, 39-42; proj. officer, Aero Med. Lab, Holloman Air Force Base, 46-53; Chief, Field Lab, 53—AF, USA, 42-45. Aero Med Asn, Am. Med. Asn. Aviation medicine, altitude flying crashing; ditching; impact injury; industrial medicine

Resources at Aeromedical Laboratory, Wright Air Development Center, Air Research and Development Command

Requested by Select Committee on Astronautics and Space Exploration

Biophysics branch

Personnel:

Field of work	Civilian	Military	Field of work	Civilian	Military
Medicine	1	10	Engineering	3	6
Veterinary medicine	0	1	Electrical engineering	6	0
Medical technology	2	0	Machinist (master)	1	0
Pharmacology	0	1	Psychologist	0	1
Biology	0	2			
Physiology	2	1	Total	20	24
Anthropology	5	0			

Facilities (major):	*Use*
(*a*) Human centrifuge (20 ft radius).	Physiological, mechanical, and some engineering testing. G-protection devices and related equipment development.
(*b*) Small animal centrifuge.	Basic research in microcirculation.
(*c*) Isolation chambers (1 large, 2 small).	Psychological and psychophysiological studies in the areas of stress, fatigue, and performance.
(*d*) Specialized medical instrumentation group.	Supports varied projects requiring highly specialized medical and physiological data recording systems.
(*e*) Downward ejection rig.	Studies of the human factors in escape from aircraft.
(*f*) Deceleration tower (under construction).	For use in testing various types of Air Force equipment (e. g., restraint systems, seats), studies of vertebral injury sustained in escape from aircraft. Equipped to record several types of physiological and mechanical data.

Research effort: Dollar value for fiscal year 1958, $713,302.
Research problems for civilian investigation: None.

Clothing Branch

1. The following research resources are available to the Clothing Branch for support of or assistance to a civilian space research program:

(*a*) *Personnel* (*all civilians*)

(1) One materials engineer (textile engineer) for establishment of requirements and applied research in the field of textiles and related materials and their application. Research and development of clothing components.

(2) One materials engineer (chemical engineer) for establishment of chemical requirements and applied research in the fields of plastics, coating, and treatments of textiles and related materials and their components.

(3) Three designers for functional, flight, and protective clothing.

(4) One designer for protective headgear.

(5) One patternmaker for making and grading patterns.

(6) Two graphics art specialists for carryout grading of patterns.

(7) Five technicians for experimental production.

(8) Five clothing samplemakers for fabrication.

(9) One cutter.

(*b*) *Facilities*

(1) Equipment to perform tests for physical and chemical material characteristics, including resistance to heat up to 3,000° F.

(2) Complete shop facilities for experimental garment production, including 50 sewing machines, electronic seam-sealing equipment, hardware installation equipment, cutting equipment, patternmaking and cutting equipment.

(c) *Dollar value*

(1) $142,724, committed.
(2) $92,000, uncommitted

Aero medical laboratory—engineering and development branch, research resources

I. Personnel:

3 General supervisory engineers	Civilian.
6 Mechanical Engineers	Do.
2 Chemists	Do.
1 Physiologist	Military.
1 Biologist	Do.
1 Chemical engineer	Civilian.
3 Engineering technicians	Do.
1 Master mechanic	Do.

II. Facilities:

Helium cryostat	Low temperature and gas properties studies.
"Norelco" gas liquefier	Do.
Rubber, fabric and limited plastic fabricator facility.	Prototype fabrication.
Oxygen generating plant (2)	Low temperature and gas properties studies.
Water test tank (40 by 40 feet)	Capsular water survival tests and submerged atmosphere tests.
Heat, cold, and low pressure laboratory test facilities.	Testing purposes

II Dollar value: Contract funds, $600,000 per year.

IV. Suggestions:

A. Suggestions as to research projects which might lend themselves to civilian investigations:

1. Project tasks:
   - Equipment for life support in astronautical operation.
   - Respiratory support equipment
   - Nutritional support equipment.
   - Refuse management.
   - Crew survival problems and equipment.
   - Integrated systems of life-supporting equipment.
2. Project tasks:
   - Life-supporting elements for space flight.
   - Composition and conversion of respiratory gases.
   - Composition and conversion of body wastes to reusable form.
   - Interaction of composite regenerative cycles.

B. Suggestion of research problems:

1. Biological gas exchanger.
2. Zero "G" oxygen converter.
3. Carbon dioxide decomposition cell.
4. Chemical respiratory closed system.
5. Hydrogen peroxide respiratory closed system.
6. Miniature feeding console.
7. Crew survival compartment.
8. Waste disposal unit.
9. Human waste water recovery unit.

Physiology Branch

A. Personnel:

	Component
1 administrator, (research and development)	1 military.
3 bacteriologists	2 military, 1 civilian.
4 biochemists	3 military, 1 civilian.
4 biologists	Do.
18 chamber operators	18 military.
2 chemists	2 military.
4 engineers	1 military, 3 civilian.
3 engineering technicians	3 civilian.
1 food service supervisor	1 military.
1 health physicist	Do.
1 home economist	Do.
1 instrument and model maker	1 civilian.
7 medical officers	4 military, 3 civilian
3 nutritionists	1 military, 2 civilian
4 optometrists	3 military, 1 civilian
1 pathologist, veterinary	1 military.
14 physiologists	6 military, 8 civilian.
1 pharmacologist	1 civilian.
3 scientific aids	2 military, 1 civilian
3 veterinary medical officers	3 military.

B. Facilities

1. Facilities for all types of human and animal physiological testing under extremes of heat, cold, humidity, and altitude as follows:

(*a*) All-weather environment chamber:

Size 13 feet by 18 feet by 10 feet high.

Capacity: 10 bench seats.

Temperature range: $-40°$ F. to $+165°$ F. (control within $\pm 3°$ F.).

(*b*) Environmental test facility (under construction).

Size: Test space 4 feet by 8 feet by 6 feet high.

Capacity: 1 subject, plus 1 observer in lock.

Altitude. 100,000 feet maximum ascent to 100,000 in 6½ minutes; descent to ground level in 7½ minutes.

Environmental capabilities:

Wall temperature. $-65°$ F. to 500° F. in 2½ minutes, 500° F. to $-65°$ F. in 5 minutes.

Air temperature: $-50°$ F. to 350° F. in 5 minutes, 350° F. to $-50°$ F. in 6 minutes.

Relative humidity: 0 to saturation in 4 minutes.

Air velocity: 50 ft./min., 800 ft./min. in 4 minutes, 800 ft./min. 50 ft./min. in 4 minutes.

(*c*) Temperature and humidity test equipment and instrumentation for recording physical variables.

(*d*) Air source for conditioned ventilating air and allied instruments.

2. Facilities for conducting biochemical and toxicological investigations involved in human factors aspects of astronautical operations as follows:

(*a*) Biochemical, clinical and toxicological laboratory.

(*b*) Pathological and histological laboratory.

(*c*) Small animal colony.

3. Altitude chambers used to investigate human responses to simulated high altitudes as follows:

(*a*) Altitude Chamber—Door 6 feet x 6 feet—0 to 100,000 feet altitude.

(*b*) Altitude Chamber—Door 2½ feet x 6 feet—0 to 70,000 feet altitude $-65°$ F. to $+160°$ F.

4. Isotope laboratory contains facilities and instrumentation to conduct isotope studies involved in physiological and biochemical investigations.

5. Nutritional Assay Laboratory. This laboratory contains standard biochemical apparatus, including the following items: fume hood, Kjeldahl nitrogen apparatus, fat extraction apparatus, analytical balances, oxygen bomb calorimeter, muffle furnaces and vacuum oven, gas analyses apparatus with meter, refrigeration equipment, autoclave, centrifuge, spectrophotometer, pH meter, water distilling apparatus, and allied equipment. This equipment will support a program consisting of basic nutritional and biochemical factors relating to inflight and space feeding.

6. Microbiology and Cellular Physiology Laboratory. This laboratory contains standard micro-biological apparatus, including the following items: Aterile hood (for tissue culture), fume hood, Warburg, refrigerated and nonrefrigerated centrifuge, incubator, autoclave, freezer, pH meter, analytical balance, spectrophotometer, microscope, and other corresponding equipment. This laboratory, as it is presently equipped, supports all microbiological and tissue culture requirements for the study of space environment and space feeding.

7. Experimental Food Preparation Facility. This laboratory is used to translate and apply nutritional requirements into feeding programs. Formulate packaging procedures. Develop storage and service techniques.

8. Bacteriological laboratories equipped to conduct studies on the vulnerability and defense of Air Force installations to bacterial warfare agents.

9. Bacteriological air-transportable trailer laboratory with facilities for BW research on pathogenic micro-organisms

10. Optical laboratory equipped for the investigation of visual problems concerned with air operations and facilities for simulating high intensity flash phenomenon involved in nuclear explosions.

C. Dollar value of contract research: $1,800,000.

D. Research projects which might lend themselves to civilian investigation:

1. Acceptance of precooked dehydrated foods Determine the effect of continuous and repetitive consumption of a limited number of precooked dehydrated foods on their preference ratings and the extent to which they may be rejected. This will involve studies of 6-month duration in which captive test subjects would be essential.

2 Determination of types and amounts of food constituents to incorporate into low-residue feeding regimens for space feeding.

3. Determination of the physiological compatability of feeding concentrated and purified foods.

4. Electrolyte and water balance studies under stresses of space environment (elevated temperatures, zero gravity, etc)

5. Development of acceptable types of feeding devices for use in space travel (under zero gravity conditions)

6 Determination of caloric requirements of man existing for varied lengths of time under space travel environmental conditions.

7. Determine the nutritional requirements under conditions of continuous low-level radiation, and the value of certain nutrients in enhancing the rate of repair from the effects of such radiation.

8 Determine the effect of continuous low-level radiation on infectivity and resistance of animal hosts and the protective effects of proteins, carbohydrates and fats

9. Determine site of action of radiation, utlizing tissue culture techniques.

10 Investigation of visual factors in air-air detection.

11. Effect of space flight environment upon the normal flora of the respiratory and digestive tracts.

12. Effect of high-altitude radiations upon the virulence of pathogenic microorganisms for experimental animals.

TRAINING PSYCHOLOGY BRANCH

1. Number of personnel identified by technical specialty and component:

	Assigned		Vacant [1]	
	Civilian	Military	Civilian	Military
Research Psychologist	13	3	10	2
Engineer	5	1	2	
Apparatus Technician	2			2
Education Specialist	1		1	
Total	19	4	13	4

[1] These vacant positions are a portion of those recently allocated to Wright Air Development Center as a result of the reorganization of the personnel and training program in the Air Force. It is expected that they will be filled by September 1, 1958. Approximately 15 additional personnel spaces will be available when the present vacancies are filled.

2. Facilities and potential uses:

(*a*) Ten small analog computers and associated equipment are available for studies to determine the necessary conditions for training, and evaluating, operators (ground and space) in the operation of precise and complex control systems.

(*b*) Seven automatic tutoring devices are available for research on more efficient ways of training maintenance personnel.

(*c*) Several experimental devices are available for studies of more efficient ways to teach personnel how to troubleshoot complex electronic equipment—such as the equipment at launch and tracking sites.

(*d*) Space for experimentation, and the multifold miscellaneous support facilities, are available for research on the necessary training conditions to support space systems.

3. Dollar value of the contract research effort:

Fiscal year 1958	$128,000
Fiscal year 1959	[1] 585,000
Fiscal year 1960	[1] 790,000

[1] Ceiling (with new responsibilities).

4. Suggestions for research projects which might lend themselves to investigation by a civilian agency:

(*a*) Determination of the training that is necessary so that a man will not panic, or perform unreliably, even under the extreme stress (or stresses) of isolation, acceleration, and unforeseen emergencies. Perhaps the studies will include the use of drugs or hypnotism to synthetically induce stresses for training purposes.

(*b*) Determination of the training that is necessary in order for a man to interpret his own physiological cues to unsafe environmental conditions, such as excess carbon dioxide, ozone, irradiated atmosphere, etc.

AIRCREW EFFECTIVENESS BRANCH, AERO MEDICAL LABORATORY (WCLDH)

1 officer, B. S. Biology, 8696, Research and Development.
1 officer, B. S. Bacteriology, 8696, Research and Development.
1 officer, B. S. Mechanical Engineering, 8636, Mechanical Engineer.
1 officer, B. S. Psychology, 8461, Research and Development Administrator.
2 airmen, 58170, Parachute Supervisors.
2 airmen, 92270A, Personal Equipment General Supervisors.
1 civilian, 8696, Research and Development Officer (Survival Equipment Supervisor).

2 civilians, 92270A, Equipment Specialists (Personal Equipment).
1 officer, M S Ichthyology, 8446, Research and Development Administrator.
1 civilian, B S Industrial Management, 8464, Engineering Technician
1 Officer, Doctor of Optometry, 8696, Research and Development Officer.
2 officers, B S Mechanical Engineering, 8636, Mechanical Engineer.
1 officer, M. A. in Psychology, 8596, Research Psychologist.
1 civilian, Mechanical Engineering, 8696, Research and Development Officer.

BIOACOUSTICS BRANCH

1. *Personnel*

The Branch is made up of 36 technically qualified persons under the supervision of a research physicist who has had considerable experience in directing research in biophysics and bioacoustics. The Branch functions as five unified multidisciplinary research teams.

(*a*) A team of 13 persons with the highly specialized capabilities for measuring, evaluating, and controlling the acoustic fields generated by missiles and space vehicles during flight and launch. Technical specialties represented on this team are as follows:

1 civilian physicist.
4 military physicists
1 civilian electronics engineer
1 military electronics engineer
1 civilian mathematician.
1 civilian mechanical engineer.
1 military mechanical engineer.
1 civilian master instrument designer.
1 civilian electronics instrumentation specialist
1 military electrician.

(*b*) A team of seven persons with experience and capabilities for investigations on the effects of large amplitude transient accelerations and impact on men and animals. These investigations include studies of the physical characteristics of the body, physiological response and psychological performance under adverse conditions. Scientific and technical specialties represented are as follows:

1 civilian biophysicist.
1 civilian medical doctor
1 military medical officer, neurophysiologist.
1 military nuclear research officer.
1 military electrician.
1 electronics engineer.
1 electronics instrumentation technician.

(*c*) A team of six persons under the direction of a senior neurophysiologist. This team possesses capabilities for conducting basic and fundamental studies on the neurophysiological properties of animal and human sensory systems. Examples of these systems are the hearing organ, the vestibular apparatus, and the central nervous system. Specialties represented on this team are as follows:

1 civilian Ph.D.-M. D. neurophysiologist.
2 military medical officers, neurophysiologists.
2 military research biologists.
1 civilian electronics engineer.

(*d*) A team of six persons with specialized experience and capabilities for developing improved methods and techniques for the protection of personnel against hazardous exposures of high intensity noise and vibration. Specialties represented are as follows:

1 military research physiologist.
1 military research clinical psychologist
1 military research and development officer, biologist.
1 civilian audiologist.
1 military Ph D, speech and hearing specialist.
1 military medical officer, neurologist

(*e*) A team of four mathematicians and physicists with specialized knowledge and capabilities for applying mathematical methods and interpretations of the noise fields and shock waves generated by space vehicles under launch, flight, reentry, and recovery conditions Capabilities are also on hand for defining the effects of sound, shock, and vibrations in biological and other visco-elastic media.

Specialities represented are as follows:
1 civilian research mathematician.
2 military mathematicians.
1 military physicist.

2. Facilities

(*a*) *Bioacoustics research facility.*—A specialized acoustic research and development building with 15,911 square feet of floor area on two floors. Special wall and floor construction provides reduction of sound and vibration transmission. The facility is used for conducting studies pertaining to the action of sound and vibration on man; the generation of sound and vibration by Air Force equipment, the development, design, and test of noise and vibration control equipment, the development of protective procedures and other bioacoustics research programs. Low noise level rooms are available for calibrating bioacoustics and physical acoustics equipment such as microphones, level recorders, analyzers and audiometers. A special anechoic room provides a working space of the following dimensions: 22 feet by 22 feet by 22 feet. This room is used for research, development, and test experimentation where conditions simulating sound propagation is free space are required Such research projects include hearing studies on man and animals, the calibration or microphones, the study of the acoustical properties of jet sound sources and the calibration of special sound sources for generating very intense sound fields. To serve these functions the noise transmitted from the outside to the interior of the anechoic room is nondetectable by the human ear. Three reverberation rooms are used for testing sound control structures, for human and animal experiments requiring intense uniform sound fields and for evaluating the transmission loss of wall materials to be used in Air Force noise control structures.

Special laboratory rooms are available in the facility for research on human hearing, effects of noise on the ear and for electrophysiological and neurophysiological studies on the responses of man and animals to noise.

b. The vertical accelerator.—For use in determining the effects on humans or animals of buffeting, low frequency-high amplitude vibrations and impact The vertical accelerator will handle a maximum specimen weight of 400 pounds The specimen table has a total excursion of 20 feet peak to peak and operates up to 3 g from 1 cycle to 10 cycles per second. In addition it has an auxiliary vibrating motion which is driven off of the hydraulic system and operates at one-fourth inch peak to peak from 10 to 20 cycles per second. The machine was designed to simulate buffering, vibration, and impact encountered in operational situations in the Air Force.

(*c*) *Vibration table.*—A mechanical shake table for studying the physical, physiological, and psychological effects of vibration on humans. The table can be vibrated in three directions with variable amplitude in each direction. Frequency range is 10 to 50 cycles per second. Maximum specimen weight is 500 pounds. Maximum acceleration obtainable is 10 g.

3. Dollar value

The annual dollar value of the research effort of the Bioacoustics Branch is $5,000,000.

4. Suggested projects

(*a*) *Studies relating to vibrations, transient acceleration, and impact encountered in space vehicles.*—The objective will be to (1) acquire quantitative measurement of vibration, transient acceleration and impact encountered by occupants in launch, power flight, and atmospheric reentry of space vehicles; and (2) measure the physiological response of experimental animals subjected to these environments. Vibratory and accelerative patterns encountered will be simulated for study in the laboratory. Physiological measurements under actual flight conditions will be made for those environments which cannot be simulated in the laboratory.

(*b*) *Destructive noise and vibration environments.*—The technical objective will be to define the dynamic characteristics (vibration, noise, aeroelastic instability, and dynamic loads) in rocket-propelled vehicles This will reveal the important problem areas with respect to structure dynamics and accessory environment thus providing needed guidance in envolving a scientifically valid vibration and sound technology. Such basic data are essential in setting up design and labroatory simulation requirements and in advancing space technology toward the objective "Man in Space."

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ENGINEERING PSYCHOLOGY BRANCH

1. Number of personnel identified by technical specialty and component.

	Assigned		Vacant [1]	
	Civilian	Military	Civilian	Military
Research psychologist	25	12	20	3
Electronics engineer			2	
Engineering aide			1	
Mathematician	1		1	
Physicist			1	
Guided missile officer		1		

[1] These vacancies are a portion of those allocated to WADC as a result of the recent reorganization of the personnel and training research program in the Air Force. It is expected that they will be filled by September 1, 1958

Approximately 20 additional slots will become available when the present slots are filled.

2. Facilities including research capability, and use to which these facilities may be put.

(a) *C–131B aircraft.*—Completely instrumented for studying the performance and physiological reactions of aircrew members in flight. Also can be used to study brief periods of weightlessness as they effect the unrestrained man.

(b) *C–11B jet simulator.*—Completely instrumented for studying pilot performance as a function of a wide range of variables. Combines the reality of a flight situation with the control of the laboratory.

(c) *Air-bearing platform.*—Useful in studying man's ability to control body rotation in the vertical dimensions under conditions where he has little frictional contact with his environment. Such research is relevant to the problems of personal locomotion in space.

(d) *Gimbled device (3–D).*—Similar to device described above except that it allows "frictionless" movement in the three rotational dimensions. Useful in studying man's ability to control his body position and rotation in space.

(e) *Four-poster*—This device is useful in obtaining objective, quantitative indices of the mobility restrictions imposed by space suits and other protective garments. Such data are useful in evaluating protective garments and in designing work spaces for crew members wearing such garments.

(f) *Analogue commuters and function generators.*—This equipment is useful in simulating control display systems in real time and in studying human performance as a part of such systems.

(g) *Generalized laboratory space and equipment.*—The branch has a large amount of generalized laboratory equipment useful in studying all aspects of human performance as a part of a man-machine system Approximately 4000 sq. ft. of air conditioned laboratory space is also available.

3. Dollar value of your research effort (contract):

Fiscal year 1958	$789,000
Fiscal year 1959	[1] 1,084,000
Fiscal year 1960	[1] 2,073,000

[1] Ceiling.

4. Suggestions as to research projects which might lend themselves to civilian investigation.

(a) Effects of radiation on human performance. This would, of course, have to be limited to radiation which can be produced on earth.

(b) Effects of extended periods of isolation, confinement and sensory deprivations on human performance.

(c) Effects of exposure to high intensity, low frequency magnetic fields on animal and human behavior.

(d) Effects of ionized breathing atmosphere on human performance.

This needs exploring.

Second, the usefulness of a man either for reconnaissance or attack purposes in an orbiting vehicle of modest altitudes, say, 150 miles.

Third, the feasibility of putting a man on a so-called stationary orbiting vehicle at 22,000 miles distant from the earth, potentially a very useful observation platform for meteorological purposes and

relay station for electronic communication. Formidable problems of supply and transportation between earth and such a space platform would have to be solved.

When we have explored those three possibilities, then I think we will know to what extent man can be justifiably used from a military standpoint in space research and defense.

Mr. McDONOUGH. To what extent can we simulate these conditions without going up there?

Colonel STAPP. We lack one factor, a very important factor, which cannot be duplicated on earth. That is the effect of weightlessness.

In the case of the Dynasoar, or boost glide type vehicle, a man will be exposed to about 8 minutes of rather severe acceleration, then 30 or 40 minutes of varying degrees of subgravity, including 7 or 8 minutes of weightlessness, followed by a fairly prolonged low continuous decelleration in the reentry and recovery phases.

His ability to adjust to these numerous and frequent changes would have to be evaluated before we could determine just how much better a man would be than a black box in controlling the operation of such a weapon.

Mr. McDONOUGH. In other words, it is impossible to simulate the environment on earth inside of the cabin through all of those phases.

Colonel STAPP. We can simulate everything as long as it is one gravity or higher. If it is subgravity, we can only simulate that for periods of one minute or less in jet aircraft going through a parabolic trajectory, or shallow outside loop flight, where the force of gravity is offset by centrifugal force.

Mr. McDONOUGH. Now will you review the problems in the second one?

Colonel STAPP. The second one is prolonged weightlessness which cannot be simulated on earth. If you are going to keep a man up in orbit for twelve 1½-hour revolutions, that will be 18 hours of exposure to weightlessness. The only way we can find out how a man reacts to 18 hours of weightlessness is to put him in orbit. There is no way we can do it in any simulator at ground level.

And in regard to the third military application, I use the word "feasibility."

We have an extremely well-worked-out plan for getting man in space; it is the joint effort of all the laboratories of Wright Field.

This plan is classified, and it will be available for closed consideration by this committee if you so desire.

The CHAIRMAN. Have you completed your statement, Colonel?

Colonel STAPP. There is just one more point that I would like to cover. In relation to the value of a civilian agency as compared to the military agency in carrying out research with man.

In previous testimony, it was brought out that the boundaries between military and civilian approaches to space research began somewhere on the other side of the moon. I daresay that a military vehicle could get beyond the moon without being challenged.

However a vehicle with military insignia, inadvertently coming down on the wrong part of the earth might bring about numerous problems as compared to a well designated, well advertised purely civilian vehicle.

I would think that a civilian agency would have a great deal more freedom of research in terms of where the vehicle could come down

without misinterpretations leading to retaliation or exorbitant demands for reparations or other embarrassments.

That is all.

The CHAIRMAN. Mr. Metcalf, do you have any questions of either one of these gentlemen?

Mr. METCALF. Thank you, Mr. Chairman.

I would like to ask two questions. First, as I understand it, Dr. Strughold, the point at which you go from let us say terrestrial medicine to space medicine is, you say, 120 miles.

Dr. STRUGHOLD. Yes, sir. I think in order to better understand this whole field and the problems involved, we need a kind of "geography of space", a "spatiography" even in an environment which is distinguished by emptiness.

Now, first, we find within our atmosphere some environmental ecological conditions which are practically the same as those encountered in space. These space equivalent conditions begin at about 10 miles. From here on we enter space step by step and encounter total space equivalence at about 120 miles. This is the mechanical surface of the atmosphere, which means that in this altitude air resistance to any vehicle terminates. Those satellites which slightly touch the atmosphere during perigee and then go out into space again are very valuable for the exact determination of the range of this mechanical border between earth and space.

Now, above this mechanical border, around 120 to 140 miles, we enter extra-atmospheric space. But even in this area, space is different from open interplanetary space, because in certain respects the environmental, ecological conditions are still strongly influenced by the earth itself.

First of all, on one side we are protected against cosmic rays and meteorites by the earth's solid body.

Furthermore, the radiation environment in the vicinity of the earth is considerably modified by the earth's own and reflected radiation. The existence of a radiation belt formed by the geomagnetic field recently discovered through Explorer I by Dr. Van Allen also belongs in this environmental complex.

All this means that the space in the vicinity of the earth is ecologically different from open interplanetary space. But the influence of the earth gradually diminishes and at about 8,000 miles is no longer distinctly recognizable.

We may call the space in the vicinity of the earth up to about two earth radii "terrestrial space" (Krafft Ehricke), or we could call it "near space".

Above this region where the earth's influence upon the ecological qualities of space becomes of minor significance, we enter "extraterrestrial space", or "outer space".

There is another possibility for a topographical subdivision of space which can be based on the gravity of a celestial body. As is generally known from astronomy, the gravitational field of any celestial body extends theoretically ad infinitum. But in astronautics the area in which the gravitational field of a celestial body prevails is of special interest. And this is called the "sphere of gravitational influence" in the international literature. Actually, it is the sphere of predominant gravitational influence, and we may briefly call it "gravisphere". The earth's gravisphere reaches up to about 1 million miles. This is

the "gravitational territory" of the earth. It includes the arena of the satellites. It is the "satellite space" (Clyde Tombaugh). But the actual satellite space reaches only a little beyond the moon. And for the practical satellite space, i. e., for artificial satellites—we might assume an area up to about 22,000 miles, which altitude is the 24-hour orbit. The moon has its own gravisphere or its own gravitational territory. And Mars and Venus too.

A "geography of space," or "spatiography", based on the ecological and the gravitational situation seems to me useful for the problem of military and/or civilian control of space exploration. I believe that up to about 1 million miles—that means within the terrestrial gravisphere, the military authorities and the civilian authorities should cooperate and that the vast space beyond the earth's gravitational territory could be the exclusive realm of a civilian authority; i. e., beyond about 1 million miles where the gravitational predominance of the earth terminates. How far the "sphere of military interest" actually extends within the gravisphere is up to the Armed Forces to decide.

Mr. METCALF. However, there wouldn't be any conflict, would there, when we say that one of the objectives of this new Commission, NASA, is to develop and operate vehicles capable of carrying living organisms through space. That would mean living organisms through an area of 120 miles and beyond. It wouldn't include below 120 miles.

Dr. STRUGHOLD. For a joint cooperation it would include all the area from 12 miles to 120 miles. This is the partially space equivalent region of the atmosphere. For instance, the recent high altitude rocket flights in balloons and rocket-powered planes are space operations of an experimental space equivalent type. They were carried out—to a great extent—under the same conditions found in space, but still within the atmosphere. I would like to add at this point that space medical research must be continued at the same places within the Air Force and the Navy where they have been started, and are presently being carried on. A change in this respect would cause a considerable time delay, which we cannot afford.

Mr. METCALF. Colonel Stapp, you say that there are three biomedical research laboratories the Air Force is operating at the present time?

Colonel STAPP. Yes.

Mr. METCALF. Are those available for civilian research now?

Colonel STAPP. They would be if they were authorized to go ahead on research problems for a civilian agency; yes, sir.

Mr. METCALF. What if somebody in the NACA, for example, set up some civilian research project, would these Air Force laboratories be available for those?

Colonel STAPP. On an informal basis on other problems.

I have worked with NACA. I am a member of a subcommittee on flight safety. We have done research in cooperation with NACA in that field. It was not done with any transfer of funds but just informally.

On the same basis, I have carried out space research with two agencies of the United States Navy. One, the research track at Naval Ordnance Research Station at China Lake, Calif., where we have been doing hypersonic wind blast biological experiments. The other, the Navy's large centrifuge at Johnsville. We work at laboratory level in complete harmony and with very little formality.

Mr. METCALF. Now, suppose the National Science Foundation, the National Academy of Science, had some civilian project to try to work out, do you think that they would be able to make use of these laboratories under the present legislation?

Colonel STAPP. There are administrative angles there that might become formal and a little beyond my knowledge on the subject. However at laboratory working level I am sure that we would be able to do any work anybody wanted.

Mr. METCALF. However, if this new Agency were created, there could be the fullest use of that laboratory and the coordination of that laboratory.

Colonel STAPP. Absolutely. In fact it would be to the best interest of our national capability if such an Agency made use of our laboratories rather than to set up competing laboratories that would derive their personnel from our staffs.

Mr. METCALF. Have you read the proposed bill that is before us?

Colonel STAPP. Yes, sir.

Mr. METCALF. Are you satisfied this bill gives enough authority to the Agency so that it could coordinate that work in these laboratories.

Colonel STAPP. I hope that is so; particularly after talking with some of the people in NACA.

Mr. METCALF. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. No questions.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. No questions.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Dr. Strughold on page 2 of your statement you say for several years the Russians have stood on their own feet and the progress made by them is evidenced by animal experiments in rockets and by Sputnik 2.

The only animal experiment that I know of is Sputnik 2. Do you know of other experiments in animal experiments that we have conducted in satellites?

Dr. STRUGHOLD. Yes. About 2 years ago they sent dogs up to an altitude of about 100 kilometers. And they were brought back to the earth by parachute.

Mr. McDONOUGH. Did they find any more out from that than we found out from Major Simmons?

Dr. STRUGHOLD. No. The results of these experiments were the same as in similar rocket experiments carried out with monkeys by Dr. J. Henry in 1952 in Holloman Air Force Base.

Mr. McDONOUGH. I think you have made quite a contribution to the committee. I appreciate your appearance here.

No further questions.

The CHAIRMAN. Mr Keating.

Mr. KEATING. Colonel, you handled the experiment of Major Simmons, did you not? You supervised that?

Colonel STAPP. Yes, sir; I was in charge of it. It was my idea in the first place. I took complete responsibility for the experiment.

Mr. KEATING. Is he all right now? He had no ill effects whatever?

Colonel STAPP. None except the ill effects of numerous banquets and luncheons.

Mr. KEATING. None as a result of the experiment?

Colonel STAPP. No, sir.

Mr. KEATING. Why can't we simulate weightlessness for longer than 5 or 6 minutes in an experiment? In other words, if we can do that that long, why can't we do it longer?

Colonel STAPP. Well, the jet aircraft has to climb to 20,000 or 25,000 feet altitude and get up to speeds exceeding 400 knots. And then go into this shallow outside loop and maintain it to a point where pullout must be accomplished in order to keep from getting too low and endangering aircraft with hitting the earth. This limits duration to less than 1 minute.

Mr. KEATING. That is the way you simulate weightlessness.

Colonel STAPP. That is right. Such an experiment is vitiated by about 3 times gravity of force acting on the aircraft during entry into this configuration; and then a pullout of 3 or 4 times gravity at the end of the brief exposure, so that we cannot discriminate between transition effects and maintained zero gravity effects.

Mr. KEATING. Do you plan any new experiments, similar to the one which Major Simmons went through, in the near future.

Colonel STAPP. We plan a similar flight in June.

Mr. KEATING. That is all.

The CHAIRMAN. Mr. Ford?

Mr. FORD. Dr. Strughold, why is the introduction of the metric system so essential?

Dr. STRUGHOLD. For several reasons: First, the metric system or the gram-centimeter-liter system is so simple and clear. It therefore has no deterrent effect upon students to enter the field of natural sciences. It also makes it easy to understand immediately the international literature, and it is therefore not so time consuming as the English system. This system of the old colonial times cannot survive this coming space age. The metric system based on 1, 10, 100, 1,000, and so on, should be generally introduced now, just the same as it is in the monetary system.

The introduction of the metric system in the Soviet Union is to a great extent responsible for the success of the Russians in rocketry. They introduced it in October 1917.

Before and during the last war, the Russians had no experience in the construction and operation of large rockets of the V-2 type. They had experience with small rockets, and they also had a good knowledge in the fundamentals of rocket science.

However, after the war they obtained the blueprints of the V-2 which, of course, were based on the metric system. And immediately in 1946 they began to build V-2's. They could do it without time delay, because they did not need to translate the metric system into the old czaristic system of measures.

Mr. FORD. What system did they use prior to October 1917?

Dr. STRUGHOLD. They used units of measures, such as the arshin, pud, and werst, which are similar to those of the English system. After the October revolution, they switched over to the metric system in science and technology with regard to tools, work machinery, and so forth. Because of this, they were able to build V-2's themselves, and since 1947 they have built several thousands of them.

Consequently, they had a whole arsenal ready for training purposes, and I am of the opinion that this is one of the reasons that they have met with such success in this field.

I would like to add here also that if you attend any meetings on astronomy, astronautics, rocket, or satellite panels here in the United States, you will observe that the metric system has recently come into use more and more just the same as in nuclear physics. But in certain areas, such as engineering, this is not yet so.

Mr. KEATING. How did you get into this space medicine field?

Dr. STRUGHOLD. I started with aviation medicine in 1927. And to get in space medicine is nothing else but a matter of logic. There is nothing particular about it.

Mr KEATING Thank you very much.

Mr. CHAIRMAN. Doctor, I was interested on page 4 as to how research can be improved, and you put your No. 1 by minimization of redtape. Will you clarify that, please? We understand it, but we want it in connection with you gentlemen.

Dr. STRUGHOLD. I have no particular things in mind. But I would like to emphasize that there are too many committees. I mean in the engineering and scientific sector. Sometimes too many completely incompetent people have to give their approval. As an example, I would like to refer to a certain project of Dr. Walter Dornberger which, from a medical point of view, seems sound to me. Dr. Dornberger has been to Randolph Air Force Base at least three times since 1954 to discuss all the medical problems involved. And I had the opinion 3 years ago that he would have his vehicle in the sky in about 1957. But this is not the case, and I think that this is due to too many committees to which he had to submit the project for approval.

Mr. CHAIRMAN. You have given excellent testimony, both of you gentlemen, on the space medicine, the logical extension of aviation medicine. Is there any relationship? Could there be any relationship between biological and chemical warfare in space medicine?

Colonel STAPP. Very remote. Because safe use of such agents in terms of difficulty of getting them exactly where you want them would demand that you use a vehicle close enough to the earth to assure accurate placement of the chemical or the biological agents.

In other words, it takes airplanes or rockets to get the biological or chemical agents where you want them.

The CHAIRMAN. We read a lot about ballistic missiles, and so forth. But I understand that the potentialities of chemical and bilogical warfare are very far reaching. I am not talking now in connection with outer space. But I am talking about the situation that confronts us. Isn't that so?

Colonel STAPP. Well, I was a little confused at first because I was under the impression that you were thinking of using a space vehicle to carry biological or chemical warfare agents. A ground-to-ground or air-to-ground rocket or even a ballistic missile might be an effective vehicle for carring such agents to a target.

The CHAIRMAN. If, in other words, any potential enemy of ours or actual enemy should get far ahead of us in the field of biological or chemical warfare, it could be disastrous?

Colonel STAPP. Yes, sir. Likewise, psychological warfare.

The CHAIRMAN. Yes, I will include that also. And psychological, as you have used it, you mean as generally understood; isn't that right?

Colonel STAPP. Yes, sir.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Doctor Stapp, would you be in favor of a provision—rather I should frame this in the affirmative—would you be in favor of a provision in the bill which would require the agency to use available facilities whenever they are in existence?

Colonel STAPP. Yes, sir. Because that would be the best way to conserve the effectiveness of these Air Force laboratory facilities.

Mr. FELDMAN. I believe that as between the military you have such a working arrangement in existence at the present time?

Colonel STAPP. We do; yes, sir.

Mr. FELDMAN. Is it possible that space stations——

The CHAIRMAN. Pardon me. In other words, you can easily make arrangements where, in connection with your laboratories and facilities, the military exigencies or considerations would not be ignored and the military be in control but make arrangements with the Space Agency or any other Agency where they could make use of your facilities under some kind of coordinated plan or cooperative idea.

Colonel STAPP. Yes, sir. Because the space research would be the same. Only the applications would differ.

The CHAIRMAN. And the interchange of information is valuable too.

Colonel STAPP. Yes, sir. And the same vehicle would carry experiments that would have different interpretations, or carry different experiments, civilian and military.

The CHAIRMAN. Your answers to these questions are very important because they become a part of a record which sort of shows the intent of Congress to a great extent. And these questions are not asked idly, because we realize the importance of establishing as broadly as possible the record. So that has a lot of governing influence after a law is passed.

What would be the approximate value of the facilities that you are connected with?

Colonel STAPP. We have 422 trained people working at the Aero Medical Laboratory at Wright Field. And I would estimate that two-thirds of them are doing work which has either direct or indirect application to space.

There are some 10 additional laboratories at Wright Field that would give use close support. For example, the equipment laboratory prepares, and does research on all parachutes that we would use in any recovery phase of a space experiment.

The plan which Wright Field has prepared, which I will try to obtain for the closed consideration of the committee, illustrates beautifully how these laboratories work together. The amount of resources in terms of equipment, dollar value of man-hours, and of the facilities brought to bear on the problem, depends on the size of the problem.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Colonel Stapp, you spoke of a report that is being prepared. How soon will that report be ready, do you know?

Colonel STAPP. That should be ready within the next 10 days.

The CHAIRMAN. By the way, you gentlemen both will have the opportunity of editing your testimony and enlarging and more fully expressing your views upon reflection. And without objection the report will be made a part of the record.

Colonel STAPP. Thank you.

Mr. FELDMAN. Dr. Strughold, at the opening of these hearings Dr. von Braun described the project he was interested in which would send a man up in a Redstone 150 miles and give the man about 6 minutes of weightlessness. I believe 30 to 40 seconds is all that is possible by existing means. Would you characterize the von Braun plan as a circus stunt or useful from the space medical point of view?

Dr. STRUGHOLD. From the space medical point of view I would say if we consider such an experiment as a preliminary phase for the preparation of a more advanced operation, let's say into the neighborhood of the moon, it is a valuable experiment.

First of all, a man in such a vehicle would be familarized with the accelerations during the active period—this means during the launching. Second, he would have about 6 minutes of weightlessness, which is at least 7 times the total circulation time of our blood. Third, we would get some more information about the deceleration effects during reentry.

Mr. KEATING. May I interrupt there?

Mr. FELDMAN. Certainly.

Mr. KEATING. Is the circulation time of the blood of a chimpanzee about the same time of a human?

Dr. STRUGHOLD. It is a little shorter. The total circulation time of the human body is 55 seconds, or equivalent to 65 heartbeats.

Mr. KEATING. And the chimpanzee would be a little bit less than that?

Dr. STRUGHOLD. Yes, sir.

Mr. KEATING. And an animal like a mouse is much less?

Dr. STRUGHOLD. Yes, sir.

Mr. FELDMAN. Colonel Stapp, what is the maximum number of g's of gravity acceleration that you have experienced in rocket sled rides?

Colonel STAPP. 46.2 g's during a total exposure of one quarter of a second.

Mr. FELDMAN. What does that mean?

Colonel STAPP. It means applying 8,000 pounds of force for 80 milliseconds, during a total exposure to 250 milliseconds. That is 4 tons of mechanical force against the body.

Mr. FELDMAN. I was thinking of some standard measurement we could have by which we could compare this kind of force with the normal force, for example.

Colonel STAPP. If you went from 60 miles an hour to a stop in 3 feet, you would be exposed to the 8,000 pounds of force, but perhaps not for the same duration.

Mr. FELDMAN. In other words, it is a question of impact, is it?

Colonel STAPP. Impact force, yes. And that is applicable mainly to accidental forces.

Mr. FELDMAN. How would that be of value in connection with space flight?

Colonel STAPP. It at least proves that a man could survive some accidental very high exposure to force that might occur in a space missile flight.

However, of a little greater importance are experiments we have done on the centrifuge at Wright Field where we have simulated the

three stages of the rocket in terms of the magnitude and duration of force of gravity applied to the acceleration of the rocket. We find that a man can operate a guidance device for as long as 3 minutes while subjected to 8 times the force of gravity, applied transversely, or going from front to back of the body; and that with 12 times gravity an exposure lasting more than a minute can produce a blackout. Space accelerations have to be kept below 8 times gravity as a maximum, although as high as 10 times gravity could be allowed briefly.

On reentry it might be necessary to trade off a long exposure to a fairly low gravitational force to avoid excessive heating due to air friction. In other words, accomplish reentry slowdown by a prolonged deceleration in the outer atmosphere rather than by plunging steeply into resistant atmosphere and overheating.

We, therefore, have done centrifuge experiments where a man was exposed to 3 times gravity across the body for 1 hour. We found that 4 times gravity could be tolerated for about 20 minutes before it became too laborious as far as breathing is concerned.

Mr. KEATING. You personally participated in these sled experiments, did you not?

Colonel STAPP. That is right. I have had 29 sled rides.

Mr. KEATING. How fast did you go?

Colonel STAPP. The fastest I have gone is 632 miles an hour. That is not as important as the fact that I stopped in 1.4 seconds.

Mr. KEATING. You stopped in what?

Colonel STAPP. 1.4 seconds.

Mr. KEATING. Did you have any physical ill effects from that?

Colonel STAPP. I was put in the hospital for observation for five days at the end of which they turned me out on flying status. Therefore, there were no serious effects.

Mr. KEATING. Could you see all right after that?

Colonel STAPP. I had a temporary disturbance of vision after the exposure to this sudden stop, for a period of about eight minutes. All I could see was a red haze. But when I was put on a stretcher, the blood drained away from my eyes and I was able to see again.

Mr. KEATING. You volunteered for that experiment, didn't you?

Colonel STAPP. Yes, sir. And I would be prepared to do some more.

Mr. KEATING. I want to commend you for your courage. I think it is remarkable.

Colonel STAPP. Thank you, sir.

The CHAIRMAN. Any further questions?

(No response)

The CHAIRMAN. Well, Doctor Strughold and Colonel Stapp, we appreciate very much your appearings before us this afternoon.

Your testimony is very valuable because it is another part in making a well-rounded record for Members of the House and those discerning minds in the future who will be interested in it.

We appreciate your appearing before us, both of you gentlemen.

And as chairman, for myself and the other members of the committee I express my thanks to both of you, to Doctor Strughold and to you, Colonel Stapp.

Thank you very much.

(Additional material submitted by Dr. Strughold follows:)

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Medical Problems Involved in Orbital Space Flight [1]

Hubertus Strughold [2]

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After analyzing the various kinds of space operations that might be expected in the near or remote future (space equivalent flight, circumplanetary space flight, and interplanetary space travel), the second phase—circumplanetary space flight or orbital space flight—is chosen as a platform for the discussion of some of the most important medical problems involved in space operations. First, the state of weightlessness is discussed with regard to its effect upon the general well-being of the occupants of a satellite vehicle and in regard to its sensomotor effects. In connection herewith, the optical situation is considered with regard to the properties of the environment and the visual appearance of the light sources. Furthermore, physiological day-night cycling is discussed in an environment where there is no natural day and night. And finally some problems involved in human engineering of the space cabin concerning pressurization, supply of oxygen and removal of carbon dioxide, photosynthetic gas exchange and the event of sudden decompression of the cabin are discussed. Some of these problems are presently under study in an experimental space cabin simulator.

INTRODUCTION

For about seven years space medicine—a branch of aviation medicine—has been studying the human factors involved in flights into the upper atmosphere and beyond, into space. There are various phases of this kind of flight depending upon the physical and physiological characteristics of the environment, the speed of the vehicle, and upon the destination of the flight.

The first phase of space operations that we can expect in the immediate future will be the long distance flights at supersonic and hypersonic speeds through the space equivalent regions of the higher and upper atmosphere. These flights will be the logical development of the present-day long distance atmospheric flights on a global scale and can justly be called global or long distance space equivalent flights. With regard to motion dynamics, part of the time the vehicle exhibits airplane status and part of the time projectile status. We are now at the threshold of this first phase of space flight, namely, global space equivalent flight (10, 27).[3]

The second phase in the development of human space flight will have been achieved as soon as the orbital velocity of about 17,500 mph has been reached. This speed, which enables a vehicle to circle for a longer period of time or even permanently around the earth in an orbit, gives the vehicle satellite status. This is circumplanetary space flight or, more specifically, circumterrestrial space flight (4).

As soon as the escape velocity of 25,000 mph has been reached, the vehicle will have attained spaceship status, this will be the final phase of space flight and can truly be called interplanetary space travel (34).

It is my purpose in this paper to discuss the medical problems involved in the second phase of space operations, namely, that of circumplanetary space flight or satellite flight This is full-fledged space flight in its simplest form: full-fledged, because all of the strange environmental and motion conditions associated with space flight are encountered; in its simplest form, because the vehicle's movement is uniform with regard to speed and trajectory. Circumplanetary space flight, therefore, is an especially suitable example for discussion of the fundamental medical problems confronted in space flight. As for its technical side, see (4, 9, 11, 21, 24, 25, 26, 31, and 34).

The first step in the direction of this phase of space flight is the instrumented unmanned satellite, such as the one to be launched in 1957 (18); but we shall take a step further and assume, for the purpose of our discussion, an instrumented manned satellite. We shall not, however, discuss how this vehicle arrives at its

[1] Presented at the ARS 25th Anniversary Annual Meeting, Chicago, Ill., Nov. 14-18, 1955
[2] Chief, Department of Space Medicine. Mem ARS.
[3] Numbers in parentheses indicate References at end of paper.

orbit and the medical (acceleration) problems involved—which are not insurmountable—but rather we shall presume to be at the stage where the vehicle has already reached a certain orbit and has attained satellite status. But, I should like to add at this point, this paper in no way directly relates to the scientific satellite program which is presently under way.

The speed required to attain satellite status is about 18,000 mph near sea level. The denser regions of the atmosphere would prohibit this speed because of air resistance and friction heat. At about 120 miles or 200 km, however, the air is without noticeable effect in both respects (5). This aerodynamic and aerothermodynamic border of the atmosphere can therefore be designated by the more general term, flight effective limit or final functional limit of the atmosphere. The actual material border of the atmosphere, however, reaches into the area of 600 miles or 1,000 km from where we enter, through a 600-mile-wide spray zone, into interplanetary space. But it must be emphasized that even above the final functional border the atmospheric environment is space equivalent in practically every respect. It is here that the laws of aerodynamics lose their meaning and those of astrodynamics (Romick) become fully effective, rather than at the material limit of the atmosphere.

Above 120 miles, therefore, the nearest satellite orbit is conceivable. The orbital speed required at this level is, roughly, 17,500 mph and the period of revolution is about 88 min. Naturally, with increasing altitude, the orbital velocity decreases and the period of revolution increases

For our medical discussion, let us assume the 2-hr orbit slightly above 1,000 miles, as chosen by W. von Braun for his space platform. At this altitude we are in the exosphere, far beyond the final functional limit and also beyond the material limit of the atmosphere. The particle density is about 10 per cm^3. In the 2-hr orbit the orbital velocity is about 15,800 mph.

WEIGHTLESSNESS

Characteristic of orbital flight is the fact that the gravitational pull of the earth and the centrifugal forces caused by the vehicle's inertia are balanced, which means that the vehicle and its occupants are in the state of weightlessness or zero gravity. This is the first of the medical problems that I would like to discuss. There are two sides to this problem: (*a*) the general medical aspect regarding the well-being of the occupants, and (*b*) the sensory physiological aspect concerning perception of position of the body in space and senso-motor control of the movement of the body and its parts.

So far, experiments on man—to study the effect of zero gravity (16)—have been carried out only up to 30 sec. in parabolic flight maneuvers in jet planes. The experiments of E. R. Ballinger (2) in Wright Field Aero-Medical Laboratory in 1952, those of Harold von Beckh in Buenos Aires (3) in 1953, and most recently those of S. J. Gerathewohl in Randolph Field, Tex., do not as a rule indicate a general disturbance in the automatic nervous system which controls respiration and circulation. J. P. Henry et al. (17) in their recordings on monkeys in a V-2 and an Aerobee during a 3-min. period of zero gravity, found no evidence of a significant disturbance of the cardiovascular or respiratory system. So far, we have no proof that there would be any difference during a longer period of time, such as would be found in a satellite. A possible shift in blood pressure, due to the absence of hydrostatic pressure in the blood vessels, might be easily regulated by the presso-regulators of the arterial system. The whole problem boils down to the question of the possibility of adaptation to the state of zero gravity. Such adaptation seems to be a possibility At this point, I should like to add that a manned artificial satellite is the only means of bringing about a final solution of this entire problem, because it alone offers the possibility of experiencing the gravity-free state for periods of days, weeks, and months, not too far from the earth.

As to the second, or the sensory aspect of the gravity-free state, this can be said: we have several sense organs, or specific nerve endings, that serve as gravireceptors, such as the centrally located otolith organ and the receptors of the pressure sense distributed peripherally over the entire skin (about 20 per cm^2), specific nerve endings in the muscles, the so-called muscle spindles, and, finally, specific nerve endings in the connective tissue, the Pacinian corpuscles. They all, belong to the category of mechanoreceptors, these receptors have an exteroceptive function insofar as they react to external forces and inform us about the outer world. One such external force is the gravitational pull of the earth. They also have an enteroceptive or a proprioceptive function insofar as they inform us about the tension conditions in the skin, the muscles, and the connective tissue.

They play, therefore, an important role in the sensomotor control of the movements of the whole body as well as of its parts. In the case of the vestibular apparatus and the pressoreceptors of the skin, the exteroceptive function is more pronounced, in the other mechanoreceptors, the proprioceptive function is dominant.

In the gravity-free state the exteroceptive or the gravireceptive function of the mechano-receptors is eliminated, the proprioceptive function, however, is not. For this reason, a man making a high dive from a diving board is able to perform a variety of acrobatic jumps quite skillfully, although he is in a gravity-free state throughout the dive. In a gravity-free state the absent gravireceptive (exteroceptive) function of the mechanoreceptors is substituted by the exteroceptive sensory organ par excellence: the photoreceptors or, in other words, the eyes. When in the gravity-free state, as in a satellite, the eyes will be the only sense organ that informs the occupants of their position in space. This brings us to the problem of vision in space.

VISUAL PROBLEMS

Of what kind are the light sources that confront us in space? Direct sunlight and starlight are first, we are also confronted by indirect sunlight coming from the earth, reflected by the continents, the oceans, and especially by the clouds. Moreover, some of the indirect sunlight is scattered from the denser layers of the atmosphere back into space. Finally, we have indirect sunlight reflected from the moon's surface. But there is no skylight and this is the factor that makes the visual conditions so strange in the regions where satellites are conceivable. Skylight is sunlight scattered in all directions by the air molecules. Because the short wave part of the visible spectrum is especially affected, the scattering produces the diffuse blue daylight in the denser regions of the atmosphere, as it is observed from the earth's surface. Against this rather bright skylight, during the daytime the stars fade into invisibility. With increasing rarefication of the air molecules in higher altitudes, scattering of light diminishes gradually and ceases at about 80 to 100 miles (15). This is the optical functional border between atmosphere and space or the visual space equivalent level within the atmosphere. It is the dividing line between atmospheric optics and space optics. Beyond this level the sky is permanently dark. The extra-atmospheric sky luminance is only 10^{-5} mL as compared with that of 500 mL the average value in the lower atmosphere. But the sun is visible in its full brilliance against the dark sky, except of course when the satellite moves through the shadow of the earth. The stars are also visible all the time, and when its position allows, the moon can be seen in full brightness together with the sun. Because of the lack of skylight in space, the contrast between light and dark is a dominant feature. Everything that is exposed to sunlight appears in full brightness and vivid color, and everything else is in the darkness of shadow. The extra-atmospheric illumination is around 13,500 ft-c compared with 10,000 ft-c at the earth's surface. Light and shadow dominate the scenery, comparable to the light and shadow effects such as those produced on the stage for the magician. This strange photoscotic condition poses physiological problems in the field of contrast vision and retinal adaptation (7, 15). And the strange distribution of the light sources, sun, stars, and the indirect sunlight from the earth and moon, is of special interest from the standpoint of orientation in space (6).

At this point I should like to make a comparison with an environment that is, so to speak, the extreme opposite of that found in space, namely, the deep sea. But there are also some similarities, according to the well-known proverb, "les extremes se touchent."

W. Beebe observed in his "bathysphere" that the light intensity in the sea decreases rapidly with increasing depths. At a depth of 1600 ft., light is completely absent in the Atlantic Ocean. In these regions we find fish with luminous organs and telescopic cylindrical eyes. At depths of about 10,000 ft. there are fish with only vestigial eyes. These deep sea fish rely almost entirely on the mechano-sensory system of their skin to sense the environment. This represents an extreme contrast to the situation that will be experienced by man under space conditions. In the darkness of the deep sea, where the photo-receptors are out of function, the position and movement of the fish is controlled solely by the gravireceptors, in the darkness of deep space and under the gravitational conditions of orbital space flight where the gravi-receptive function of the mechano-receptors is eliminated, orientation of man depends entirely upon the photo-receptors or upon vision.

We do not know whether man can adjust to purely optical orientation in space. Fish can be trained for an optical orientation in their environment. Several years ago it was found by E. von Holst that when an aquarium in a dark room was covered with a black plate and the light penetrated through the glass bottom, some of the fish will swim upside down, and will look for fresh air at the bottom which is lighted and will swim to the dark surface of the water when they want to rest.

In orbital space flight, the sun, the stars, and the earth and moon are the optical footholds for the visual orientation in space. The observation of the sun, however, poses an important medical problem. The brilliant radiance of the sun in its original intensity, while not affected by atmospheric absorption and scattering, represents a hazard to the eyes. A much shorter time of exposure is sufficient to cause a retinal burn, such as that known to the ophthalmologist, as it occurs occasionally when someone observes a solar eclipse through an insufficiently smoked glass. The result of such a so-called "eclipse blindness" is a scotoma or a blind spot in the visual field. Outside of the atmosphere, the danger of such a retinal injury by direct solar light is much greater, and from an artificial satellite the sun should be observed only through glass with very high absorptive power.

In connection with the optical conditions found in the space equivalent regions of the atmosphere beyond 120 miles and in interplanetary space, I should like to touch upon a physiological problem that has never been discussed in space medical papers. It is the problem of maintenance of an adequate physiological day-night cycle for the occupants of a space vehicle.

PHYSIOLOGICAL DAY-NIGHT CYCLING

In orbital space flight, the concept of natural night loses its meaning and must be replaced by that which night really is, namely, the shadow of the earth.

The shadow or umbra of the earth tapers down in the form of a cone 859,000 miles or 1,385,000 km deep into interplanetary space. Travling through the greatest width of this sunless dark cone would take our assumed satellite about 50 min. During the remaining part of the revolution (about 70 min.) the vehicle is exposed to the sun and surrounded by darkness at the same time, as described earlier. Such are the optical conditions if the satellite orbit passes through the earth's shadow.

Many different orbital planes, however, are conceivable; in every case at a distance of about 1,000 miles an adequate ambient physical day-night cycle is absent because the day-night or, more precisely, the sunlight-shadow cycle is only 2 hr. Therefore, we must create and maintain an artificial day-night cycle within the satellite to meet the physiological requirements of the occupants. For, adequate diurnal cycling is of great importance to the health and efficiency of man. In fact we are physiologically so strongly adapted or so bound to a day-night cycle, manifested in rest or sleep and wakefulness or activity, that it must be regarded as a biological law. To ignore this law, after a week or so, would lead to a complete nervous breakdown (19, 33).

How can an adequate day-night cycle be achieved for the occupants of an artificial satellite? For them, the night must be induced in a special night compartment or by a device covering the eyes. The question is posed as to the time pattern of such an artificial day-night period.

In this regard, reference is made to the important basic experiments carried out in the Mammouth Cave in Kentucky, 1940, by N. Kleitmann, Professor of Physiology at the University of Chicago (19). Dr. Kleitmann spent two months in this cave with several co-workers, under artificially regulated day-night cycles of different lengths. The result of these experiments showed that man can adapt himself to a diurnal cycle only in the range from 18 to 28 hr. Within this range the temperature curve of the body follows the various cycles. When a cycle shorter than 18 hr or longer than 28 hrs was introduced, no adaptation was possible and the temperature curve returned to its normal cycle of 24 hr.

This gives us the clue for solving the problem of diurnal cycling in a manned satellite. If we choose a minimum day-night cycle of 18 hr, dividing it into 8 hr for sleep, 2 hr for recreation, and 8 hr for duty, that would be a reasonable solution. Or, if a 24-hr day-night cycle is selected, the best plan for a subdividion of this cycle would be 8 hr for sleep, 8 hr for rest and recreation, and 8 hr for duty. This presupposes that the crew will be large enough to be subdivided into three groups. In the case of an artificial 18- or 20-hr day-night cycle, a two-group crew would be sufficient for a manned satellite operation.

HUMAN ENGINEERING OF SPACE CABIN

We may assume that the metabolic rate of an occupant of an artificial satellite during his duty hours is about the same as that of an individual on earth during moderate work; the total metabolism during a 24-hr period, including sleep and recreation, would then be on the order of 2,500 cal for a 70-kg. man This brings us to the respiratory requirements for the satellite crew or, more generally speaking, to the climatization of the cabin (1, 13, 22, 7). The cabin in a satellite must, of course, be completely closed—a sealed cabin in which an adequate atmosphere is artificially created and controlled. It must be emphasized, however, that such a type of cabin is required even down to the atmospheric region of 70,000 to 80,000 ft.

One of the vital tasks in the climatization of the sealed cabin is the solution of the oxygen problem for respiration.

From the aforementioned metabolic rate of 2,500 cal per man per day, we can calculate the amount of oxygen required by 1 man per day. The thermal equivalent of 1l of oxygen is 4 85 cal under normal nutritional conditions. This means that the biological production of 1 cal requires 206 cm^3 of oxygen. Consequently, the total amount of oxygen consumed per man per 24 hr is roughly 500 l or 0.7 kg. This amounts to 58 kg of oxygen per man for 1,000 satellite revolutions that take place in 83 days in our assumed orbit at the 1,000-mile altitude, or 348 kg O_2 for a crew of 6. Replacement of the consumed oxygen from the storage tanks must be controlled in such a way that the oxygen pressure does not fall below 100 mm. Hg. This is about the minimum permissible limit for comfort and efficiency; it should not surpass the permissible maximum of about 350 mm. Hg because O_2 concentrations above this level are toxic (8). This shows that we can tolerate a rather wide variation in oxygen pressure (from 100 to 350 mm. Hg), which facilitates considerably the oxygen problem in space flight.

Whereas oxygen is consumed in the metabolic processes of the body cells, carbon dioxide is produced in the same process and exhaled. Under normal nutritional conditions, the ratio between exhaled carbon dioxide and consumed oxygen, the so-called respiratory quotient, is 0 85. In our example, one man produces 425 l of carbon dioxide or 0 837 kg. per day or 70 kg. per 1,000 satellite revolutions. This would be 420 kg. for a crew of 6. Carbon dioxide in concentrations above 3 vol. percent is toxic, the permissible limit for a longer period of time lies at about 1 vol. percent under standard barometric pressure and temperature conditions, or at about 8 mm Hg. The removal of the excess carbon dioxide in the sealed cabin vehicle, which can be achieved by certain chemicals or in a physical way is, therefore, just as vital as the maintenance of an adequate oxygen pressure.

Since the consumed oxygen appears again in bound form, namely, within the carbon dioxide of the expired air, it has been suggested to try to regain the oxygen from the carbon dioxide, in this way eliminating a toxic gas and at the same time facilitating the problem of oxygen supply.

A natural method accomplishing this is known to us in the process of photosynthesis, found in chlorophyl-bearing plants. Photosynthesis is the reverse process of respiration as a comparison of their reaction formulas shows

Respiration: $C_6H_{12}O_6 + O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$
Photosynthesis: $6CO_2 + 6H_2O + \text{Light Energy} \rightarrow C_6H_{12}O_2 + O_2$

In respiration or biological oxidation, oxygen is consumed and carbon dioxide and water are produced. This process requires several so-called respiratory enzymes In photosynthesis, oxygen is produced and carbon dioxide and water are consumed This process requires the presence of chlorophyl as an enzyme.

In special studies sponsored by the USAF School of Aviation Medicine, it has been found by J. Myers, head of the Department of Algal Physiology, University of Texas, Austin (23), that 2 3 kg. fresh weight of a certain alga—the alga chlorella pyrenoidosa—with regard to gas metabolism, under optimal conditions, is sufficient to support one man. This means that this mass of algae consumes as much carbon dioxide and produces as much oxygen per time unit as one man produces carbon dioxide and consumes oxygen during the same period of time. Both, therefore, could live together and support each other with regard to the respective respiratory and photosynthetic requirements in a symbioticlike relationship in a closed system for a considerable length of time.

Plants like the alga chlorella are especially suitable as photosynthetic gas exchangers. They are small round bodies about the size of red blood cells and are dispersed in a nutritional solution. These primitive plants are perfect photosynthetic machines, since they have no specific organs nor various functions like the higher plants. Their only function is to build up carbohydrates and to produce oxygen photosynthetically. Primitive plants of this type appeared on this planet 1½ billion years ago. And they might have been responsible for an early buildup of an initial stock of oxygen in the primitive atmosphere or proto-atmosphere of the natural satellite of the sun, namely, the earth. But the difficulties in the use of such photosynthetic gas exchangers lie in the volume and weight of the device, in the arrangement of and in the power requirement for illumination As for the latter, solar energy may be the answer. For flights of short duration, however, we certainly shall never resort to a biological gas exchanger. For flights over weeks and months it might be different. Perhaps some day we shall have a type of photosynthesis that can utilize infrared; or the efforts that have been made for a number of years in order to achieve artificial photosynthesis may one day be successful.

In the sealed cabin also, the water vapor given off—in amounts of from 50 to 80 gram per man per hour through respiration and perspiration under comfortable temperature conditions by the occupants—must be kept within the comfort limits that range between 80 and 50 percent relative humidity. And, finally, the barometric pressure should be kept at levels corresponding to that found near sea level and up to 9,000 ft In this respect, however, the physiologist could make concessions to the engineer, who for structural reasons would probably desire a lower pressure differential between the cabin's air and the surrounding near vacuum. From the physiological point of view, a minimal barometric pressure corresponding to an altitude of about 15,000 ft. would be acceptable.

The multitude of factors involved in the climatization of the sealed cabin requires a complex instrumentation for automatic control. The School of Aviation Medicine, USAF, Randolph Air Force Base, Tex., now has an experimental sealed chamber (fig. 1) in which we can study the changes of the atmospheric conditions caused by the presence of the occupants, and the means to control these factors. This space cabin simulator can also serve as an indoctrination chamber in handling the situation in case the automatic controls fail or the cabin develops a leak.

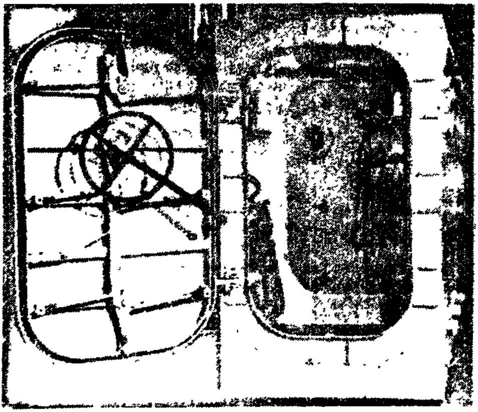

FIGURE 1 —The space cabin simulator of the School of Aviation Medicine, USAF, Randolph Air Force Base, Tex

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DECOMPRESSION EVENT OF THE SPACE CABIN

With this point we touch upon the Achilles' heel of the sealed cabin vehicle. One of the causes of a leak might be a collision with a meteor (20), a probability which is very remote; however, the occupants of a satellite vehicle must be prepared for such an event, even though meteor bumpers or screens—suggested by F. Whipple (35) and others—might offer effective protection

In the lower atmosphere, the time rate of decompression of the pressurized cabin is governed by four factors: the volume of the cabin, the size of the hole, the barometric pressure within the cabin, and the barometric pressure of the ambient atmosphere In a satellite vehicle, the last factor is practically zero, which means that under other equal conditions the decompression will be more violent. In any event, the crew must know that a drop in oxygen pressure to 100 mm. Hg will affect their efficiency, as mentioned earlier, and at an oxygen pressure of 60 mm Hg the situation will become critical and dangerous Before this critical level is reached, the source of the leak must be sealed; otherwise, the crew would face the whole physiological sequence of decreasing air pressure effects.

CONCLUSION

These are some of the medical problems encountered in obital space flight. I have not touched upon the radiation and temperature problem (12, 28, 29, 30) which has been discussed in the paper of David G Simons (30).

All of the space medical problems discussed so far are also encountered in transfer orbits to other celestial bodies, that is, in interplanetary space travel. Some of them will be faced also, more or less, during a certain portion of space equivalent flights, that is, in long distance flights at hypersonic speed through the space equivalent regions of the atmosphere, as previously defined But we find them, so to speak, in classical form in nearly circular orbital space flight.

I have chosen, therefore, this phase of space operations for this paper because it offers an ideal platform for the discussion of the problems of space medicine in general, and provides an up-to-date picture of some of the progress made in this fascinating branch of aviation medicine.

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The Possibilities of an Inhabitable Extraterrestrial Environment Reachable From the Earth

By Hubertus Strughold,[1] M. D , Ph. D.

The problem of life on other worlds is a subject which captivates the imagination of mankind tremendously. Not until it was recognized by Copernicus in 1543 that the earth is not the center of the universe but rather only one of the members of the planetary family of the solar system, could such thoughts arise in the human mind. There are two technical events that have had a catalytic effect upon man's occupation with this question: The invention of the telescope some 350 years ago, which has brought the celestial bodies closer to us optically, and recently, the successful development of the rocket which possesses the potentialities of bringing us closer to them physically. Not only has the older question of the existence of indigenous life on other planets come anew into the focus of scientific and general public interest, but in addition, with the development of space operations, this question is posed: Are there planets in the solar system that offer an environment of such kind that an astronaut from the earth—the species homo sapiens terrestris—could land there and stay there for some time at least?

We get an answer to both of these points very quickly by projecting the specifications of the environment required, from the standpoint of human physiology and of general terrestrial biology, against the physical planetary data offered in the astronomical literature.

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Such a study can be called planetary ecology. For the science which particularly studies the possibility of indigenous life on the planets the terms "astrobiology" and "astrobotany" are in use. With regard to this latter problem this discussion will consider only the kind of life known to us, based on carbon as the structure atom and on oxygen as the energy liberation atom.

Table I shows a list of certain ecological factors indispensable for the existence of life such as: the presence of an atmosphere and a hydrosphere, or water in its liquid state, a biologically suitable temperature, carbon dioxide which is, in addition to water, the raw material for photosynthesis in green vegetation, and finally, oxygen, the key element in the biological energy liberation. The table further shows, by use of the marks + and − whether or not these ecological factors are found on the planets of our solar system. By screening the planets in this way, only Mars and Venus remain as bioplanets or conceivable bioplanets. And these planets are found in neighboring orbits near the sun only. The decisive factor responsible for this zonation of the planets with life-favoring conditions is the intensity of solar radiation which decreases with the inverse square of the distance from the sun. The difference in the radiation intensities to which the planets are exposed, and have been exposed since their protoplanetary stage, are therefore tremendous.

TABLE I.—*The planets and some of the ecological necessities for life*

Planets	Atmosphere	Hydrosphere	Biotemperature	Carbon dioxide	Oxygen
Mercury	−	−	−	−	−
Venus	+	(+)	+	+	(+)
Earth	+	+	+	+	+
Mars	+	(+)	+	+	(+)
Jupiter	+	(−)	−	−	−
Saturn	+	(−)	−	−	−
Uranus	+	(−)	−	−	−
Neptune	+	(−)	−	−	−
Pluto	+	(−)	−	−	−

+ present, (+) probably present in small amounts
− not present, (−) present in frozen state.

We get a dramatic picture of this by considering the size of the sun as seen at the distances of the various planetary orbits (Fig. 1). To an observer on Mercury the diameter of the solar disk would appear more than twice the size it does to us on earth As seen from Mars, the sun would have a considerably smaller apparent dimension than our moon. At the distance of Jupiter the sun's diameter is only one-fifth as large as seen from the earth, and at the distance of Pluto the sun would appear no larger than the evening star Venus appears to us on earth. This means that in the more remote portions of our planetary system, the role of the sun, as dominating source of light and heat energy, fades into that of a common star. If there were people on Pluto, these Plutonians would not even know the concept of a sun This consideration makes it quite clear why life-supporting planets are conceivable only in a certain zone within the planetary system.

More in detail, the visible section of the solar radiation spectrum presents a narrow zone of physiologically desirable planetary illumination, a kind of "euphotic belt" surrounded by dysphotic (hyperphotic and hypophotic) regions. With this we have added a new ecological factor not mentioned in Table I, namely, light. The infrared portion of solar radiation, as the main carrier of heat energy, is apparently effective in providing biologically acceptable temperatures on planets only in the range from Venus to Mars, which justifies our speaking of a "biotemperature belt" in the planetary system. The occurrence of water in this same zone represents a kind of "liquid water belt" in the planetary system (5).

Finally a zonal distribution is evidenced in the chemical composition of the planetary atmospheres. On the inner planets we find atmospheres containing oxygen, and such oxygen compound as carbon dioxide, while the atmospheres of the outer planets contain hydrogen and such hydrogen compounds as methane and ammonia. Originally about two and one-half billion years go, the atmospheres of all the planets were basically hydrogen and reduced atmospheres. This protoatmospheric composition dominated by hydrogen has been transformed in the course of many millions of years into one of oxygen and oxidized compounds by the effect of ultraviolet of solar radiation, but only on the planets relatively near the sun, namely, on Venus, Earth, and Mars. These planets, therefore, form a kind of atmospheric "oxygen belt" in the planetary system.

The atmospheres of the outer planets, moving beyond the effective reach of ultraviolet solar radiation, are still protoatmospheres preserved in a frozen state. They form a "hydrogen belt" of the primordial brand in the planetary system. But Jupiter, nearest to the sun in this outer belt, shows some indication of photochemical reactions in the upper atmospheric regions, manifested in green and reddish colorations, which have recently been interpreted by Rice (4) as caused by free radicals of methane and ammonia in a frozen state.

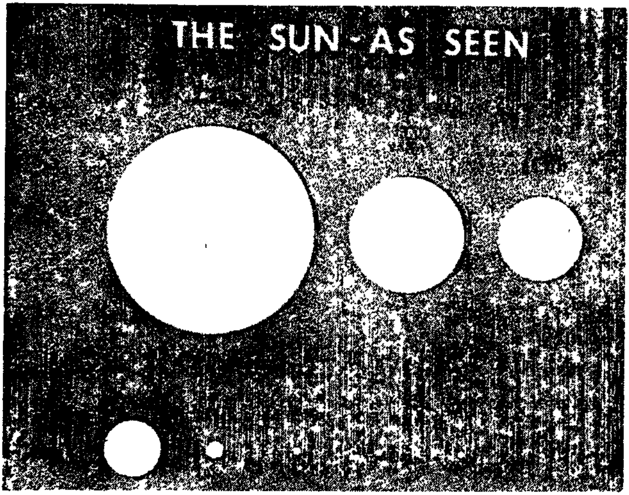

FIGURE 1.—Size of the sun as seen from the orbital distances of the various planets.

In summary, this general ecological consideration leads us to the assumption of specific life favoring ecological belts in the planetary system such as an euphotic belt, biotemperature belt, liquid water belt, and oxygen belt. Because all of these belts are found in about the same region, they are therefore parts of a "general life zone" which we might call "ecosphere" in the solar planetary system and which is confined to the orbital range from Venus to Mars (fig. 2). This is the zone on the planets in which the kind of life now predominant on earth is conceivable. On the planets in the hydrogen belt, micro-organisms such as hydrogen-, ammonia-, methane-, and iron-bacteria, are conceivable; these are the kind which probably populated the earth during its protoplanet stage some two billion years ago and which we still find today in the pores of the soil and other poorly aerated spaces. However, the low temperature on the outer, so to speak, permafrost planets excludes the possibility of life in the hydrogen belt. The sun's radiation in this region apparently has not been sufficiently effective to change the atmospheric environment on these planets into a biologic climate.

For all of these reasons, it would be ecologically impracticable to extend space operations beyond the well irradiated ecosphere to the outer planets with their hydrogen, methane and ammonia saturated atmospheres, and their arctic temperatures and surrounding midnight sun light conditions. But even the two ecologically acceptable planets, Venus and Mars, pose considerable medical problems. Because of lack of time, I will omit a discussion of Venus, whose surface features are wrapped in mystery by dense clouds of carbon dioxide, and shall concentrate upon Mars.

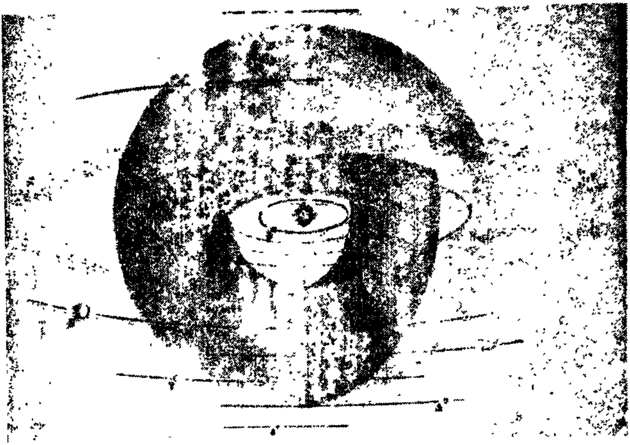

FIGURE 2.—Ecosphere or life zone of the planetary system comprising Venus, Earth, and Mars. Within this sphere lie the eupnotic biotemperature, liquid water and oxygen belts. All are essential to support life as we know it.

Of primary interest to the astronaut will be the question of the kind of atmospheric environment he would find there from the standpoint of human physiology, especially what protective measures he would have to take concerning respiration.

Atmospheric entry will pose fewer aerodynamic, aerothermodynamic and pertinent physiological difficulties than are encountered in the terrestrial atmosphere because of the lower air density. The most likely chemical composition according to de Vaucouleur (7) is as follows 98 5 percent nitrogen, 1.20 percent argon, 0.25 percent carbon dioxide, and oxygen < 0.12 volume percent The barometric pressure at ground level (there is, by the way, no sea level on Mars because of the absence of open bodies of water) is about 70 mm. Hg. or 95 millibar. This pressure corresponds to an altitude of 55,000 feet in our atmosphere (fig. 3). Barometrically, this altitude is the Mars equivalent level in our atmosphere. The oxygen pressure at ground level is probably lower than it is in our stratosphere.

Pilots flying at altitudes above 55,000 feet must wear pressure suits. The same would be required for an astronaut on Mars when he leaves the sealed compartment of his spaceship However, an air pressure of 70 mm. Hg. lies just within the critical border range in which a pressure suit, or simple oxygen equipment with pressure breathing, are a matter of dispute. Oxygen equipment with pressure breathing may be sufficient for shorter periods of time. Balke, (9) after spending six weeks at a height of 14,800 feet at Morococca, Peru, for acclimitization purposes, was able to withstand an altitude of 58,000 feet in a low pressure chamber for three minutes with pressure breathing only. A certain altitude adaptation of the astronaut can be expected if the air pressure in the sealed cabin is kept at a pressure of half an atmosphere during the trip. Be that as it may, a terrestrial explorer on Mars, wearing a pressure suit or pressure breathing device must always retreat, after an hour or hours depending on the efficiency of the equipment, into the more convenient sealed compartment of the ship, which should have its landing place in the lowlands because, with regard to the respiration equipment, every milimeter of Mercury of air pressure counts. Such a depressed area, for instance, is the Trivium Charontis, a dark greenish patch several thousand feet below the level of the surrounding desert.

In the event of a leak in the sealed compartment or in the pressure suit, the astronaut would encounter the same rapid decompression effects including anoxia and aeroembolism as the pilots do in our atmospheric region at about 50,000 to 55,000 feet. He would not, however, be endangered by "ebullism" a new term

(8) for the so-called "boiling" of body fluids. This effect becomes manifest on Mars at an altitude of 13,000 feet which corresponds to 63,000 feet in our atmosphere. These are the essential points which must be considered in insuring physiological air and oxygen pressure for an astronaut A factor which might facilitate the oxygen requirement and the mobility of the astronaut is the relatively low gravity on Mars, which is 38 percent of that on earth.

The temperature in summer during the day in the equatorial regions may reach 25° C. After sundown when the temperature drops very quickly to −45° C., the space cabin must provide adequate protection. Harmful effects from solar ultraviolet rays can be disregarded. Even if they were not sufficiently filtered out by the martian atmosphere, the skin of the astronaut is always protected from sunburn by the respiratory equipment or by the cabin. Health hazards from primary cosmic rays are probably not to be expected because of the atmosphere's absorbing power. The same certainly would be true concerning meteorites.

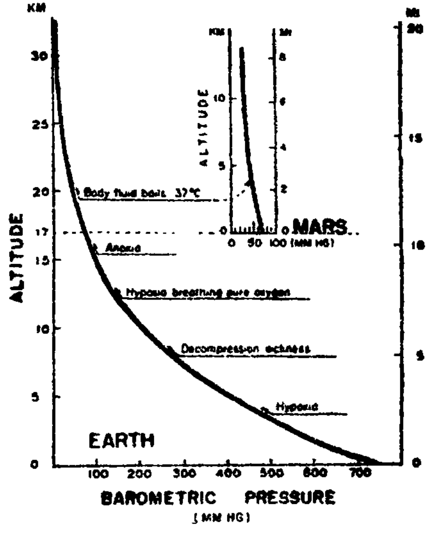

FIGURE 3.—Mars equivalent altitudes within the earth atmosphere. The altitudes and air pressures of the martian atmosphere are projected onto those of the earth. The curve shows points at which certain physiologic effects of decreasing air pressure are observed.

The intensity of daylight on Mars is lower than on earth but still in physiologically desirable limits. The color of the sky is probably whitish blue (2) due to scattering of light by the various hazy cloud layers. It might be that under this umbrella of whitish haze the sun would be invisible. Finally, an adaptation of the astronaut to a different day-night cycle is not necessary because the day-night cycle on Mars is only thirty-four minutes longer than that on earth. Such are the climatic environmental conditions that a terrestrial explorer probably will find on Mars from the standpoint of human physiology or, in other words, with regard to himself. A strange "second earth"!

Of particular interest for a terrestrial explorer on Mars will be the question: Does indigenous life exist on the planet itself? With this we touch upon the much discussed dark green areas in the equatorial regions which show seasonal color changes and therefore have been interpreted as vegetation. Will the

astronaut find that this is correct or will he find instead volcanic ash (3) or some hygroscopic inorganic material? (1) Recent spectroscopic studies seem to support the martian vegetation theory. The physical conditions are extremely severe with the exception of sufficient amounts of carbon dioxide and light. Such conditions, especially the extreme day-night temperature variations, according to terrestrial standards, could support only very hardy and cold resistant plants. We must, however, consider not only the climate as a whole but also the so-called microclimate near, on, and below the ground influenced by surface and subsurface features, snow coverings, hollows, and caves which usually moderate the extremes of the macroclimate Then there is the enormous capacity of life to adapt itself to abnormal climatic conditions. With regard to the specific environment on Mars we should consider the possibility of specific structures and properties of the plants for storing water, carbon dioxide and photo-synthetically produced oxygen. Such phenomena are well known in terrestrial biology Strong absorbing power of the plant surfaces are infrared and reflecting power for blue could be imagined as a means for temperature control and protection against ultraviolet, respectively, if the latter is necessary. The pronounced bluish tint of the green areas on Mars might offer a hint in this respect. Protection against frost might be possible if the martian plants were able to develop some kind of antifreeze such as glycerol. We know that even terrestrial animal cells can survive temperatures as low as −70° C when placed in glycerol solutions

The opinion has been expressed by Tikhoff (6) that a terrestrial climate which comes nearest to that on Mars with regard to temperature, radiation and humidity is that found on the Pamir plateau, a high mountain desert in Central West Asia, or that on the high plateau of Tibet. As previously mentioned, the air pressure conditions on Mars correspond to those in the lower region of our own stratosphere. So if we combine the microclimate of the Pamir plateau or Tibet with the macroclimatic air pressure milieu of the lower stratosphere, we have an approximation of the environment on Mars. It is more severe than on the Pamir plateau but friendlier to life than our stratosphere because of its higher temperature during the day.

Such is the picture than can presently be drawn of an extraterrestrial environment most probably reachable from the earth Whether or not this earthly conception corresponds to the martian reality, is a question that will probably remain open until a successful space operation to the green and red planet has been achieved. Until then, it will remain a common meeting place for discussion for astronomers, biologists, botanists and physiologists—in fact, for everybody.

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From Aviation Medicine to Space Medicine [1]

By H. Strughold, M. D., Ph. D.

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Space medicine appears with a special program of papers, for the first time, on the public platform of a scientific society—the Aero Medical Association. For this reason, it would seem that a few introductory remarks are appropriate. It is a privilege, and indeed a source of great pleasure, that this task has been delegated to me.

Space medicine, at first glance, undoubtedly appears to many people as a capricious or whimsical idea in aviation medicine. However, upon closer examination, it proves to be a very logical step in development. When we view it from a historical standpoint, starting with the predecessors of aviation medicine, we gain a better understanding of its scope and meaning.

Aviation medicine, throughout its 40 years of development, has benefited by the experiences gained in high-mountain physiology. As a science, high-mountain physiology is nearly 100 years old. Mountain sickness, however, was first described by José de Acosta in 1588. The first mention of this uncomfortable effect of thin air can be traced back to Greek literature, since it was Aristotle who observed that men could not live on the top of the 10,000-foot Mount Olympus in Thessaly without breathing through a wet sponge. High-mountain physiology, with all of its descendants, could very well claim as its birthplace, a holy mountain dedicated to Zeus or Jupiter.

Logically, twentieth century aviation medicine in its early years, was more or less concerned with the problems of cadet selection, reaction time, orientation, crashes, et cetera. The early issues of the Journal of Aviation Medicine tell this story. However, with the passing of time, interest in higher altitudes increased more and more. Experiments in low-pressure chambers and explosive decompression chambers opened the way into the tropopause and stratosphere. Extreme explosive decompression experiments (1), (6), (9), (12), (18), (19), and the medical evaluation of the balloon flight of the Explorer II (2) had already touched the area of space medicine. Aviation had attained a very high level in safety, efficiency, and comfort, as a result of the accomplishments of aviation medicine (1), (4), (9), (11), (21,). Only high-powered propeller planes and jet planes could still bring some progress in speed and high altitude flying

It was in this situation that the first rocket appeared in the sky and—within 5 years—exceeded all altitude records by 20 times. This was not only a signal for the engineering world, but a challenge to all sciences concerned with the human factor. This new revolutionary development becomes quite clear when we review the records of altitudes reached—during the past 150 years—by means of the balloon, airplane, and rocket. We note that the balloon and airplane, both depending upon air, are—in a way—confined to two-dimensional movement in the horizontal plane around the globe, whereas, only the rocket has really conquered the vertical—the third dimension—moving away from the earth. Considered from a global point of view, this shift in dimensions is the most conspicuous mark in the new development of flight. A new frontier has now been opened—the "vertical" frontier (5).

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[1] Presented at the 23d annual meeting of the Aero Medical Association, Washington, D. C, March 17-19, 1952. Symposium on space medicine

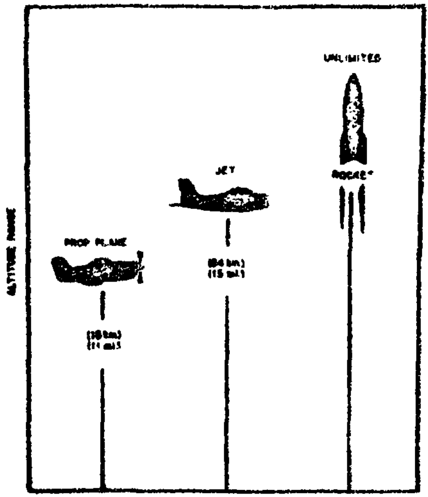

FIGURE 1. The vertical extent of the operational areas of propeller, jet, and rocket craft.

Figure 1 shows the vertical extent of the operational areas of propeller, jet, and rocket craft. The ultimate limit for propeller-driven planes is about 18 km. or 60,000 feet; for jet planes, about 24 km. or 80,000 feet; and rockets are limited only by their fuel capacity. With regard to speed, propeller-driven and jet planes have attained velocities in the neighborhood of the speed of sound. Rockets have practically no limitations of speed.

The limiting factor in height and speed, for conventional planes including jets, is the atmosphere. However, in the realm of the rocket, flying is no longer dependent upon air as a supporting medium. Thus, the factors with which we must deal in rocket flight are not properties of the atmosphere, but rather attributes of free space.

For this reason, a most logical step, and a daring one too, was the creation of a new branch of aviation medicine, space medicine In anticipation of this development, a special department, the Department of Space Medicine, was founded in 1949 by Major General Harry G. Armstrong, at that time Commandant of the USAF School of Aviation Medicine at Randolph Field, Texas. Problems concerning rocket flights were also being studied by the Aeromedical Laboratory at Wright Field about the same time.

The first open discussions in the field of space medicine were held at two earlier meetings, one called by General Armstrong in 1948 at the USAF School of Aviation Medicine, Randolph Field, Texas (3) and another organized by Dr. Andrew Ivy and Dr John D. Marbarger in 1950 at the University of Illinois in Chicago (20).

At the 1950 meeting of the Aero Medical Association in Chicago the creation of a space medicine branch of this organization was proposed, and at the 1951 meeting in Denver this branch was finally established with Col. Paul A. Campbell as its chairman. The foundation of this branch was a necessity in order that we could have a medical counterpart of the various rocket societies, space-flight societies, astronautical and interplanetary societies, which are exclusively technical in nature. It must be recognized that these societies, which exist in more than half a dozen countries, have shown great activity and success during recent years. The human factor in space flight, however, is as important as the technical factor.

Today the space medical branch of the Aero Medical Association offers a special program. Space medicine is no longer the diffuse area which it may have appeared to be a few years ago. The scope of its problems is now clearly defined. They have been clarified by the introduction of a new concept of the boundaries between the atmosphere and space, based on the function which the atmosphere has for man and craft (13, 23). This functional consideration demonstrates that at relatively low altitudes the various functions of the atmosphere cease, one after the other. Consequently, the various space factors take over. Such levels are properly called space equivalent altitudes (fig 2) In mentioning only a few of them, we meet space equivalent conditions with regard to—

Anoxia at 52,000 feet;
Body fluid boiling at 65,000 feet;
Heavy primaries of cosmic radiation at 120,000 feet; (22, 16)
Ultraviolet solar radiation at 135,000 feet; (17)
Optical appearance of the sky at 400,000 feet; (13) and
Meteorites at 500,000 feet. (34)

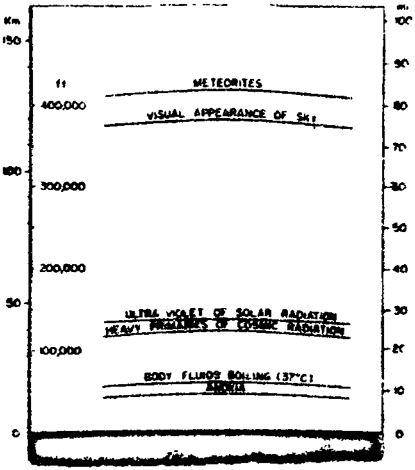

FIGURE 2.—Space equivalent and semiequivalent conditions within the earth's atmosphere. (For further details see text.)

It may be added that only the earth with its magnetic field, its radiation, and its bulk, modifies some of these conditions, making them different from those found at greater distance Since the bulk of earth affords protection from one-half of the cosmic radiation and meteorites, we may, in these particular cases, speak of semiequivalent conditions of space.

Space equivalent stages within the atmosphere must be considered in regard to the necessity for sealed cabins, and also with regard to pure radiation climate above a certain altitude. (7) Further, conditions characteristic of space originate in the motion of the craft, here, weightlessness is the most outstanding phenomenon. (8, 14, 15) This problem was first discussed by H. Haber in a seminar at the Aeromedical Center in Heidelberg in 1946 (10)

This approach, based on a functional concept of the atmosphere, clearly indicates that a differentiation must be made between two distinct regions of the physical atmosphere: The lower section is the realm of conventional flight where the properties of the atmosphere can be utilized, the upper section, beginning as low as 50,000 feet, where the functions of the atmosphere gradually become ineffective, has many properties in common with free space. It is indeed amazing

to observe that various environmental factors of space penetrate down to rather low altitudes. The usable portion of the atmosphere is a very thin shell. The so-called upper atmosphere of the physicist is equivalent to free space, for all practical purposes.

A symposium on the physics and medicine of the upper atmosphere was held in San Antonio, Tex., in November 1951. (25) This meeting, which was organized by Brig. Gen. Otis O. Benson, Jr., Commandant of the United States Air Force School of Aviation Medicine, and Dr Clayton S. White, director of research of the Lovelace Foundation, must be considered an important step toward clarifying the medical problems involved in flight in the highest strata of the atmosphere, where the various benefits derived from the presence of air fall short. The problems of flight in this area are different from those encountered in free space For this reason, the area was designated by a special term, namely, the aeropause (K. Buettner). (25) In a way, flight at present is in an amphibian stage, in a phase of transition between conventional aviation and future space flight

The technical development clearly points to the final conquest of free space. We must be prepared to meet the necessities of this day. The field of space medicine must in time be promoted to eventually cope with the human problems which will most certainly arise.

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A Simple Classification of the Present and Future Stages of Manned Flight

By H. Strughold, M. D., Ph. D. [1]

Whenever great inventions or discoveries are made, there is public concern with their potentialities and the length of time required for their full realization. This has been notably true in the application of the rocket principle of propulsion to flight. Rocket flight and space flight symbolize trips to the moon or to Mars. As long as these trips do not materialize, in the public view there is no such thing as space flight. This all-or-nothing attitude is often found in conversations, in radio and television programs, and in print.

It is true that the development of the rocket principle of propulsion is an achievement of revolutionary significance. Yet its complete exploitation will probably follow the pattern of a gradual evolution. The stages of this evolution can be understood best if we examine three factors: (1) the physiological and mechanical properties of the environment, (2) the speeds attained by rockets, (3) and distances they travel over and away from the earth.

ENVIRONMENT

It is well known that the border between the atmosphere and space, in meteorological and astrophysical terms, lies at an altitude of about 600 miles. As an environment for the flyer and the vehicle, however, the atmosphere shows conditions typical of space at much lower altitudes. We encounter within our atmosphere, beginning at 50,000 feet, a region which becomes increasingly space-equivalent with regard to one or more of the conditions, important for manned flight. These conditions are anoxia (50,000 feet), the boiling point of body fluids (63,000 feet), the necessity for a sealed cabin (80,000 feet), meteors (75 miles), and the darkness of space (100 miles). (9)

Above 120 miles we find space-equivalent conditions in almost all respects. The atmospheric region from 50,000 feet (about 10 miles) up to 120 miles may be considered partially space-equivalent, and the region above 120 miles totally space-equivalent, if we ignore certain environmental effects which are caused by the solid body of the earth, its magnetic field, and its own and reflected radiation (8) (fig. 1). Above the 120 mile level, the atmosphere is unrecognizable in manned flight. It is imperceptible to the flyer, although for the astronomer it exists up to 600 miles.

This being true, the rocket-powered plane which has carried man to 90,000 feet and the rockets which have carried animals up to 36 miles (4) have flown in a region which is space-equivalent to a high degree. A two-stage rocket, the WAC corporal mounted on the nose of a V–2, which attained an altitude of 250 miles, was flying under conditions of total space-equivalence even though for a few minutes only. Do not these achievements in very high altitude flying, justify the statement that we have already reached the era of space flight? From the standpoint of the environment we are at present in the partial space-equivalent phase of manned flight.

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Presented on March 21, 1955, at the luncheon during the annual meeting of the Space Medicine Association, Washington, D. C.

SPEED

Just as we find levels that are characteristic in the environment around the earth, so too do we find certain characteristic points in the factor of speed. They also mark distinctive stages in the development of flight (Fig. 2).

The first of these is the speed of sound (760 m. p. h. at sea level). The present record in the supersonic speed range exceeds Mach 2. In the higher range of Mach 3 or 4, in horizontal flight, centrifugal forces begin to counteract gravitation to an increasingly noticeable degree. This brings on the phenomenon of decreased weight or subgravity. Theoretically, at about 18,000 m. p. h. or 5 miles per second, in a horizontal flight the state of weightlessness, or the gravity-free state, is finally reached. This speed of 5 miles per second or 8 kilometers per second, where centrifugal force equals the gravitational pull of the earth, is known as the orbital, or better, circular velocity. It is the speed which will enable a craft to circle about the earth in a fixed circular orbit like an artificial satellite. At 7 miles per second or 11 kilometers per second, the craft breaks away from the earth's gravitational pull and escapes into the depths of interplanetary space. It is called the escape velocity.

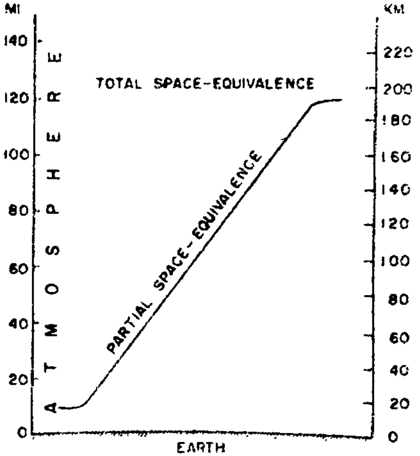

FIGURE 1 —The space-equivalent regions within the earth's atmosphere.

The highest speed so far attained in a two-stage rocket (the WAC Corporal mounted on a V–2) is 1.4 miles per second. This is 30 percent of the orbital and 20 percent of the escape velocity. This is where we stand today with regard to speed The three-stage rocket (1 5) or the atomic rocket (2.7) may bring in the remaining percentage.

DISTANCES

The various stages of flight can also be classified by the factor of the distance they cover The craft may fly from one point on the globe to another point on the globe, in a certain distance around the globe, or far away from the globe into space.

If we combine the factors of environment, speed and distance with their characteristic levels into one picture, we see an evolutionary course in the development of manned flight that looks somewhat as follows: The long distance flights of today take us at subsonic speed, under normal gravitational conditions, in pressurized cabins through the lower regions of the atmosphere from one point on the globe to another distant point on the globe, across a number of time

zones and/or across zones of different seasons in a single day. These are global atmospheric flights. This epoch in flying began when Lindberg crossed the Atlantic Ocean in 1927.

We are now on the threshold of the next stage. Rocket powered planes will take us at supersonic speed under subgravitational conditions and in sealed cabins through the space-equivalent regions of the atmosphere from one point on the globe to another even more distant point in a matter of hours (3). Still

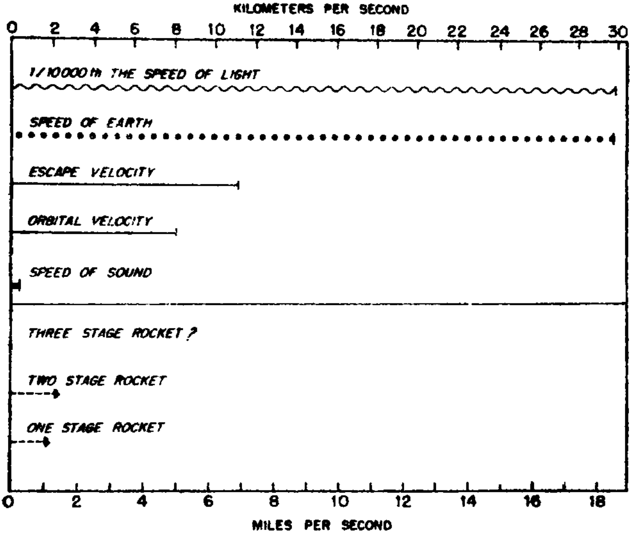

FIGURE 2.—Speed records in rocket flight compared to speed of sound, orbital velocity and escape velocity.

bound to the earth, they will fall into the category of global space-equivalent flight. The precursors of this long distance space-equivalent space flight are seen in the short distance, short time flights of rocket powered planes and unmanned rockets of today. They can be termed local space-equivalent flight.

As soon as the orbital velocity (5 miles per second) is reached, flights of long duration around the globe in a satellite orbit under conditions of zero gravity and in an environment equivalent to space will become possible. But these craft still will operate within the gravitational hold of the earth and will remain within the earth's vicinity. This eventual stage may be called circumplanetary space flight.

The next step will follow as the escape velocity (7 miles per second) is reached. When, one day, a manned rocket leaves the earth, attains this speed and moves freely in space, then we will have arrived at interplanetary space flight or what we may now call "space travel" (1) (5) (6)

This classification (table I) gives us, I believe, a clearly defined and realistic picture of the stage at which we stand today and of the possibilities we may expect in the future. At present we are actually in the first phase of space flight, the phase defined as global space-equivalent flight. Solution of the medical problems in this stage is, therefore, of immediate concern to the physiologist, the engineer, and the flyer. Incidentally, most of the medical problems involved in the final stage (space travel) are encountered in the stage of global space-equivalent flight.

This step-by-step approach to the possibilities of rocket-powered flight by human beings is perhaps more stimulating, and more fruitful for research and develop-

ment, than the all-or-nothing attitude displayed by those who constantly gaze upon remote celestial bodies like the Moon or Mars with a kind of space fascination. The psychological power of attraction of these objects as the final goal, however, must not be underestimated. They are extremely valuable as a background stimulus for our efforts toward advancement of human flight.

TABLE I.—*Classification of developmental stages in manned flight*

	I Global atmospheric flight	II Global space-equivalent flight	III Circumplanetary space flight	IV Interplanetary space travel
Distance	Geographic dimensions	Geographic dimensions.	Vicinity of earth	Interplanetary dimensions.
Environment	Lower atmosphere.	Space-equivalent regions of the atmosphere	Circumplanetary space.	Interplanetary space.
Speed	Sub- and supersonic speed	Supersonic speed	Orbital velocity	Escape velocity.
Gravitational condition	Normal gravitation (1 g).	Subgravity	Zero gravity	Zero gravity.

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SPATIOGRAPHY

(ASTRONAUTICAL ASPECT)

By Hubertus Strughold, M. D., Ph. D.[1]

Never before in its history has the imagination of mankind been captivated so much by the concept of space as today, following the rapid progress in rocketry. It is used in a great variety of versions such as near space, outer space, deep space, free space, interplanetary space, cosmic space, blue yonder, and so on. But space is an immensely vast area even within our solar system. From the standpoint of astronautics and especially of space medicine or bioastronautics, we need a specification of just what is meant by these terms topographically and environmentally

Just as the traveler on the earth's surface uses the science of geography for his orientation concerning distance, climate, etc to be encountered on his journey, so does the astronaut need a topographical and environmental description of space, a kind of spatiography for orientation, navigation, the designation of the various kinds of space operations, and the estimation of the medical problems involved. At first glance, it may seem strange to draw borderlines or demarcation lines for subdividing an environment distinguished by emptiness; there are, however, several possibilities

First, the question arises "Where does space begin?" This is the title of a paper published by the writer with H Haber, K. Buettner, and F. Haber in 1951, in which the concept of the functional borders between atmosphere and space was introduced. In this publication, it was shown that the various atmospheric functions for manned flight come to an end at various altitudes, some

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even within the lower regions of the stratosphere. The final functional limit of the atmosphere is found at a height of 120 to 140 miles, where the atmosphere aerodynamically terminates though it continues as a material medium up to 600 miles. Expressed in another way, the atmosphere begins to become partially space equivalent at about 10 miles and progresses to total space equivalence at about 120 to 140 miles, as far as the atmospheric functions are concerned. There the laws of aerodynamics lose their meaning (except for objects of enormous velocity) and those of astrodynamics become fully effective. This is the dividing line between space equivalent flight and true space operations, or between the aerodynamically effective airspace and free space. Such is the picture concerning the border between atmosphere and space as seen from the standpoint of space medicine.

Now, what are the possibilities of subdividing, for astronautical purposes, the regions beyond this border—the vast extra atmospheric void of our solar system? First, we can use as demarcation lines the orbital distances of the moon and the planets. Then we speak of cislunar space, translunar space, cismartian, and transmartian space, etc., as Frafft Ehricke has suggested. (Cislunar—on this side; translunar beyond.)

Of special interest from the standpoint of navigation is the gravitational situation in space. The gravitational field of the earth, as of every other body, extends of course to infinity. But for the astronaut, the sphere of predominant gravitational attraction is of most importance. It might be practical to call these gravitational control zones, briefly, gravispheres. The gravisphere of the earth extends to about 1 million miles This is the arena in which satellites are conceivable. Escape velocity thrusts a vehicle eventually out of the earth's gravisphere into the gravitational control zones of other celestial bodies. Thus we arrive at an astronautical subdivision of space based on the extension of the gravitational territories of the various celestial bodies.

Of practical and vital importance to the astronaut are differences in the environmental conditions of space itself. To begin with, the space environment in the vicinity of celestial bodies is different from that in free interplanetary space. It shows some peculiarities caused by the mere presence of their solid bodies, by optical properties of their surfaces and by forces originating in these bodies and extending into space

In the vicinity of the earth for instance, on one side we are protected by the solid body of our globe itself from cosmic rays and meteorites just as we are protected in the lee of a house against rain, hail, or wind. Other peculiarities of the space environment in the vicinity of the earth are the shadow of the earth and the earth's own and reflected radiation, which pose special visual problems and influence the heat balance of a space vehicle.

The forces which cause special regional environmental differences in the space near the earth are those of the geomagnetic field. The magnetic field of the earth strongly influences the influx of corpuscular rays of solar and cosmic origin by channeling them into the polar regions. The density distribution of these ray particles in adjacent space in fact shows considerable variations with the earth's latitudes.

For all these reasons, the space in the vicinity of the earth is somewhat different from open interplanetary space. To emphasize these differences, Krafft Ehricke has introduced the concept of the "terrestrial space" and assumes for it an extension of 1 earth radius or 4,000 miles where they dominate the picture. "Circumterrestrial space" might be another suitable designation. For this region within which the earth's influence upon the ecological qualities of space is distinctly recognizable, it might be advisable to use the term "near space," and for the region beyond, the term "deep space" or "outer space."

But this outer space again shows environmental differences in the various parts of our solar system. These are based on variations in the intensity of solar radiation as a function of the distance from the sun.

A vehicle in the neighborhood of Venus receives about 50 times as much heat per unit of surface area each minute as a vehicle in the area of Jupiter. This is an important factor in the climate control within the space cabin. A vehicle fitted for a trip to Venus is not equipped for an excursion to Jupiter, just as an expedition outfitted to hunt alligators in the jungles of the Amazon could not be sent to hunt polar bears in the Arctic. Any vehicle entering the mercurian space would finally run into a kind of solar heat barrier.

With respect to visible radiation, or light the sky in space is dark everywhere. However, the illumination received from the sun varies considerably. In the orbit of Mercury it amounts to almost 80,000-foot candles while at the remote distance of Pluto, it is only 8-foot candles.

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Finally, the ultraviolet range of solar radiation, which is chemically very active, has strongly influenced environmental conditions on the planets. This is shown by the division of their atmospheres into an inner oxygen belt, and an outer hydrogen belt. The first includes Venus, the Earth, and Mars. The second comprises the planets from Jupiter to Pluto. Spatiographic ecology then, covers two areas; the ecology of space itself, and the ecology of the planets, or planetary ecology.

For manned space operations there seems to be, at least for the time being and in the near future, a limited area in the solar system with regard to the ecological conditions of space itself and the planets, a kind of ecosphere as a function of the distance from the sun and the resulting radiation intensities. This sphere includes the region from Venus to Mars.

We get a dramatic impression of the radiation intensiveness of the sun in both respects by comparing the size of the sun as seen from the various planets. For instance, from the distance of Pluto the sun would not appear larger than the Evening Star, Venus, appears to us on earth.

For hundreds of years, astronomers have been mapping the stars, measuring their distances, and defining their motions. The astronomer performs these magical feats from afar while he sits behind his telescope in a well-tempered observatory, surrounded by the fresh air of Texas or the California mountains. By contrast, the astronaut leaves the life-supporting air of our planet terra and ventures far into space itself in his little terrella. He has to know where he is going, into what physical environment. He needs indeed as guidance a "geography of space," or spatiography, based essentially on ecological considerations concerning space itself and the planets.

Space Medicine and Astrobiology

(Report to be submitted to House Select Committee on Astronautics and Space Exploration, room 214, New House Office Building, Washington, D. C.)

By Hubertus Strughold, M. D., Ph. D.[1]

After a brief outline of the scope of the medical and biological aspects of space flight or astronautics, and the international situation in these fields, the following items, as requested, are discussed.

1. Medical and biological aspects of space exploration.
(a) What research is being done?
(b) What are the areas which need immediate and special attention?
(c) How can research be improved?
2. Education in the medical and biological sector of astronautics.
(a) What is the present status?
(b) How can education be improved?

Scope of research.—As a logical extension of aviation medicine, space medicine studies the medical problems in flight within the space-equivalent[2] regions of the atmosphere and outside the flight effective[3] atmosphere. They are essentially the result of the ecological milieu conditions of space and of the process of motion to, through, and return from the environment of space. The inclusion of the environment found on other celestial bodies into space medical considerations, i. e., viewed from the standpoint of human physiology and survival requires careful studies in planetary ecology in advance.

This astromedical study overlaps with astrobiology which concentrates upon the question of indigenous life on other celestial bodies. All these various studies represent specific aspects of a more general field which can be called bioastronautics.

Originating about 10 years ago, space medicine has made considerable progress in the United States theoretically and experimentally in the laboratory and in flight operations. In the U. S. S. R. the literature in cosmic medicine (as space medicine is called) follows very closely the line of thinking of the West. For several years the Russians have stood on their own feet, and the progress made by them is evidenced by animal experiments in rockets, and by Sputnik II. In 1947 the Russians founded a Department of Astrobotany.

[1] Professor of space medicine and adviser for research, Air University, School of Aviation Medicine, Randolph Air Force Base, Tex.
[2] Atmospheric range from about 12 to 120 miles.
[3] Atmospheric range from above 120 miles.

After this brief introduction, the following comments are made.

1. Medical and biological aspects of space explorations.

(*a*) What research is being done? A great deal of research has been devoted to human engineering of the space cabin as carried out in space cabin simulators. These studies concentrate upon the question of the best suitable artificial atmosphere, and of the most effective air regenerating devices Methods for recording the climatic conditions in such closed ecological systems and for recording the physiological reactions are being developed. For the past 5 years the inclusion of plants in a closed ecological system as oxygen producers and carbon dioxide absorbers has been under study at various places. The effect of increased gravity forces upon the human body is pretty well understood due to studies on centrifuges and on sleds. These have been carried out since 1935. Zero gravity is presently being studied during parabolic flights in jet planes concerning its physiological and psychological effects. The problem of day-night cycling in space operations has been and is being studied theoretically, and experimentally in space-cabin simulators. The same is true for the psychological effects of isolation and confinement. Sealed gondolas have been tested in manned balloon flights up to 102,000 feet. One man has been kept alert in a space cabin simulator for 7 days. The physiological effect of rapid decompression of a space cabin is well understood. Cosmic ray studies have been carried out in numerous balloon flights In experimental astrobiology, terrestrial microorganisms have been studied under simulated Mars conditions. These are some of the most important studies that are underway:

(*b*) What are the areas that need immediate attention?

(1) Methods of recovery and rescue during the critical launching period.

(2) The problems related to reentry.

(3) Studies concerning long-range straight-line landing maneuvers.

(4) Visibility of the earth from great altitudes.

(5) Exposure to zero gravity for longer durations.

(6) Exposure to cosmic rays for longer periods of time.

(7) Simulation of cosmic ray particles.

(8) Experimentation with artificial meteorites and their impact upon a closed cabin.

(9) Search for the most effective air-regenerating means

(10) Continuation of efforts in the development of comfortable pressure suits.

(11) Animal experiments in rockets and satellites as supporting studies for the solution of manned space operations.

(12) Interdynamic medical adaptation to space flight.

(13) Experiments in multi men space cabin simulators.

(14) Telemetering as means of monitoring the space crew.

(15) All medical problems related to the time factor in flight.

(*c*) How can research be improved?

(1) By minimization of red tape

(2) By more and better facilities.

(3) By better opportunities in the form of a sabbatical leave for scientists to visit scientific institutions here and especially abroad

(4) By the creation of a translation and distribution center of foreign literature.

(5) By the introduction of the metric system. (The introduction of the metric system by the Russians during the October Revolution of 1917 is to a great extent responsible for their success in rocketry.)

2. Education in the medical and biological sector of astronautics.

(*a*) What is the present status? For more than 5 years, space medicine has been taught in the various courses for flight surgeons at the School of Aviation Medicine, Randolph Air Force Base, Texas only.

(*b*) How can education be improved? All universities should include in their curriculums several space medicine lectures per semester. Educational films should be used on a broader scale. All pupils in grammar schools and students in high schools should immediately be familiarized with the metric system as this is the only system that—as in nuclear physics—can conveniently be used in astronautics.

In concluding this report, I should like to emphasize that all the efforts at the present time have to be concentrated on achieving a manned orbital flight in the sense of celestial mechanics. A dozen or so revolutions of such a biosatellite will reveal whether or not man can stand space flights over longer durations of time. At present it seems to me that, from the standpoint of medicine, the picture looks rosier than it did 5 years ago, but it should also be emphasized that there are limitations for space operations in our solar system. Space flight in the near and remote future will have to be confined to a certain area in our solar system. All

suggestions for operations beyond this area are not acceptable from the standpoint of space medicine and belong in the department of nonsense. For a realistic approach, factual science combined with imagination and horsesense must be the basis for planning in the exploration of space.

As a final remark I would like to add that space medical studies will be beneficial for medicine in general.

For more detailed information, the following five reprints on space medicine and astrobiology are attached:

1. From Aviation Medicine to Space Medicine, 1952.
2. A Simple Classification of the Present and Future Stages of Manned Flight, 1956.
3. Medical Problems Involved in Orbital Space Flight, 1956.
4. The Possibilities of an Inhabitable Extraterrestrial Environment Reachable From the Earth, 1957.
5. Spatiography (Astronautical Aspect), 1958.

The committee stands adjourned until next Wednesday at 10 o'clock.

(Whereupon, at 5:05 p. m., the committee recessed to reconvene at 10 a. m., May 7, 1958.)

ASTRONAUTICS AND SPACE EXPLORATION

WEDNESDAY, MAY 7, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS AND SPACE,
Washington, D. C.

The committee met pursuant to call, at 10 a. m., in the caucus room, Old House Office Building, Hon. John W. McCormack (chairman of the committee) presiding.

Present: Representatives McCormack, McDonough, Fulton, Keating, Ford, Brooks, Hays, Metcalf, Natcher, and Sisk.

The CHAIRMAN. The committee will be in order.

The first witness we have is Mr. Loftus Becker, legal adviser of the Department of State. And we are very glad to have you appear before us, Mr. Becker, and I welcome you to the committee.

Also Mr. John C. Cooper, professor of international law, at McGill University.

We like the panel idea. You both will testify and then the members of the committee will have the opportunity of asking either one or both of you questions.

We will hear from you first, Mr. Becker, and then we will hear from you, Professor Cooper.

Mr. BECKER. Mr. Chairman, if it is satisfactory to the Chair, Professor Cooper and I have briefly discussed our testimony and we would like to have him go first, if that would be satisfactory.

The CHAIRMAN. It is perfectly agreeable to the Chair. I was only following protocol. That is all. You represent the State Department. If the State Department wishes to waive its protocol status, that is all right with me.

Professor Cooper, we all know about you. But I would be very happy if you would give your background for the record.

Mr. COOPER. Thank you, Mr. Chairman. May I say in advance that I am very deeply honored to be asked to appear here, to take part in these hearings. Anything that I do have to say is entirely my own personal point of view. And I am not speaking in behalf of any organization, any committee of which I am a member, or any other connections I may have.

STATEMENT OF JOHN C. COOPER,[35] OF PRINCETON, N. J.: PROFESSOR (EMERITUS) OF INTERNATIONAL AIR LAW, McGILL UNIVERSITY

Mr. COOPER. I was born and raised in Jacksonville, Fla., and practiced law there until 1934, except for 2 years spent as a radio officer in the Navy in the first World War. I was chairman of the American Bar Association committee on aeronautical law from 1931 through 1934; and in 1933 represented the United States at Rome as chairman of the delegation to the first conference on private international air law in which the United States participated. I retired from the practice of law in 1934 to become a vice president of Pan American Airways, and, while in that capacity, at the request of the State Department, took leave of absence to become one of the legal advisers on the United States delegation at the Chicago conference in 1944, when the present Convention on International Civil Aviation was drafted. I served as chairman of the drafting committee which reported out about half of the present convention—another drafting committee handling other parts of the convention.

I retired from Pan American Airways in 1946 to become a member of the Institute for Advanced Study at Princeton, because I wanted to do some research and writing on international air law. While at the institute, I was asked to serve as one of the legal advisers to the Air Policy Commission of which Mr. Finletter was Chairman, and later in the same capacity on the Airports Commission of which General Doolittle was Chairman.

When I left the institute in Princeton in 1951, I founded and was the first director of the Institute of International Air Law at McGill University (Montreal), from which I have since retired—I am now an emeritus professor.

This information is given you at Mr. Feldman's suggestion to show that I have had some connection with flight problems, or some of these problems, for many years.

I might also say that some bibliographies indicate that one of the earliest discussions of the problem of the use of space was contained in a lecture I gave at the Naval War College in 1948. Later in a

[35] Cooper, John Cobb, lawyer, author, aviation cons.; b. Jacksonville, Fla., Sept 18, 1887; s. John Cobb and Mary (Coldwell) C, grad Lawrenceville (N J) Sch, 1905; A. B., Princeton, 1909, LL M, *McGill U.*, 1952; m Martha Helen Marvel, Jan 5, 1918, children—Rachel Irvin (now Mrs Richard W. Baker, Jr.), John Cobb III Jane Practiced law at Jacksonville, 1911–34, admitted to Bar of Supreme Ct of U. S. 1932, mem bd control U Fla., 1921–25, editor Fla State Bar Assn Law Jour, 1927–34; v. p. Pan-Am. Airways, N Y, 1934–45, dir Pan-Am Airways, N Y, 1944–46, mem Inst for Advanced Study, Princeton, N J, 1945–50, dir Inst Air Law and prof law McGill U, Montreal, since 1951. Served as ensign and lt. U S N R, 1917–19; in command Navy Transatlantic Control Radio Sta, Washington, 1918, lt. comdr. U S N R, 1920–35, Del Dem Nat Conv, St Louis, 1916, N. Y, 1924, mem for U. S. of Internat. Tech. Com of Aerial Legal Expert (CITEJA), 1932–34, 46–47; chmn. U S delegation to 3d Internat. Conf on Pvt Air Law, *Rome*, 1933, *observer* Inter-Am. Aviation Conf, Lima, Peru, 1937, adviser U S delegation and chmn drafting com Internat Civil Aviation Conf, Chicago, 1944, chmn orgn com. and v. p Internat. Air Transport Conf, Havana, 1945, mem 1st exec com Internat Air Transport Assn, 1945, and legal adviser since 1946, adviser U S *del ICAO* Commn on Multilateral Agreement, Geneva, 1947; cons. President's Air Policy Commn, 1947, President's Airport Commn, 1952; asso editor U S-Canadian Aviation Reports, mem. Air Law Com, *Internat C of C (Paris)*, mem adv council Woodrow Wilson Sch. of Pub and Internat Affairs, Princeton U, mem bd advisers Fletcher Sch. of Law and Diplomacy (Tufts Coll) Medford, Mass, Fellow Am Acad Arts and Scis, mem Am Bar Assn (chmn com. on aeronautical law 1932–35, chmn com on Am citizenship, 1949–53, administrator Am. Bar Research Center, 1953—), Florida State Bar Assn (*pres* 1931), Am Law Inst, Am Soc Internat Law, Internat. Law Assn. (London) (mem air law com), Inst Aeronautical Scis, Council Fgn. Relations, Phi Beta Kappa, Phi Beta Kappa Assos (dir, treas 1949–54) Episcopalian Clubs Fla Yacht (Jacksonville), Charter, Nassau (Princeton), Century (N. Y. C.), *University, McGill* Faculty (Montreal). Contbr. various mags Author: The Right to Fly, 1947, The Fundamentals of Air Power, 1948, Summary and Background Material on International Ownership and *Operation of World* Air Transport Services. 1948; Roman Law and the Maxim "Cujus est solum" in International Air Law, 1952. Home: 1 Armour Rd. Office: 240 Nassau St., Princeton, N J

1951 lecture in Mexico City I raised some of the specific questions I am going to talk about this morning.

Mr. Chairman, the United States, in my judgment, faces grave flight policy decisions in fields other than pure science. These may well affect its future use of space and its relations with other nations similarly engaged.

Four such decisions are of primary importance: (1) the types of flight instrumentalities to be regulated by treaty or statute; (2) the extent upward of our territorial air space; (3) control by international agreement of flight in outer space; (4) the rights of protective action in outer space by the estate below in the absence of effective international agreement.

Each of these questions should be carefully considered by any national Space Agency, acting either alone or in cooperation with those Government departments which may be directly affected by the final policy decisions.

The powers given to the Space Agency should in my judgment be sufficiently broad to accomplish these objectives.

First, as to flight instrumentalities: The present position as to the types of flight instrumentalities regulated by statute or treaty is dangerously confused. This is particularly true of the United States position.

National flight control was first made part of our statutory law by the Air Commerce Act of 1926. Flight in the future by instrumentalities other than balloons, airplanes, and similar devices which require aerodynamic lift was not considered. Aircraft regulated by the act were defined as—and this is of importance—

> any contrivance now known, or hereafter invented, used or designed for flight in the air.

Airplanes, balloons and other types of normal aircraft are of course included. Those guided missiles, such as Snark, which are equipped with air-breathing motors and therefore operate only in the atmosphere as pilotless aircraft, would also meet the statutory definition.

Grave doubt must exist, however, as to how rockets would be classified. They are powered with motors which do not require air intake for combustion. But they do pass through the "air" when used at low altitudes, and operate more efficiently outside the dense atmosphere with its inherent drag.

However, no one could possibly bring presently operated satellites or future space ships within our statutory definition of aircraft. They are designed for flight outside and beyond the "air." They are today not covered by our regulations and statutes.

The situation is in fact even more difficult. The United States is a party to the Chicago Convention of 1944 and is a member of the Council of the International Civil Aviation Organization created by that convention.

And I would say, Mr. Chairman, as a very definite legal point, the annexes to the Chicago convention are not part of the treaty. When adopted by the Council, they are referred to the several States, and unless excepted to, they are normally considered internationally binding. A very difficult situation had to be met at Chicago in 1944 because one of the difficulties to us in the Paris convention of 1919, which prevented the United States from accepting that convention,

was the fact that the annexes were part of the convention. The fact that the international committee created by the Paris convention could amend these annexes had raised serious constitutional questions as to whether the United States could ratify such a treaty which gave to an international organization the power in substance, without reratification, to modify the treaty.

When the matter was considered again at Chicago, a formula was worked out in which the annexes to the Chicago convention are not part of the convention, but are submitted afterward to the states for consideration.

This particular annex was administratively accepted by the United States. It is not technically part of our law, but practically, in my judgment, will be considered binding as to international flight unless something unusual should arise.

In this annex dealing with aircraft, adopted by the International Civil Aviation Organization and accepted by the United States, aircraft are defined as "all machines which can derive support in the atmosphere from reactions of the air." That was the same definition adopted in 1919 in the Paris convention and is, therefore, practically 40 years old; but it is still the only international definition of "aircraft."

This is even more restricted in its scope than the United States Air Commerce Act definition. No type of flight instrumentalities are internationally regulated except normal aircraft types, flying with or without a pilot, and depending for support on aerodynamic lift. Rockets, satellites, and spaceships are thus excluded.

The importance of this becomes evident when the convention itself is examined. I refer to the Chicago convention of 1944.

The body of the convention deals generally with civil aircraft. It includes such provisions as article 12, which empowers the International Civil Aviation Organization to adopt rules for flight of "aircraft" over the high seas with no limit as to height, and article 8 which provides that no "aircraft" capable of being flown without a pilot shall be thus flown over the territory of any state which is a party to the convention without special authorization by that state. Due to the limited definition of aircraft, these provisions will not be applicable to rockets, satellites, or spaceships used even for civil purposes.

But the difficulty is even deeper. Article 3 of the Chicago convention forbids the flight of state aircraft over the territory of another state without special authorization. This is the only existing international agreement on the subject. It might apply to such guided missiles as Snark, but not to those which do not "derive support in the atmosphere from reactions of the air." Certainly article 3 of the Chicago convention does not now prohibit rocket and satellite high altitude flight over the United States because such rockets and satellites are not "aircraft" as internationally defined.

The United States must examine the legal and diplomatic positions created by these narrow, outdated, and confused provisions, and reach definite conclusions as to its future position. Any civil Space Agency should take part in the recommendations when finally made. Future civil as well as military space flight will be directly affected.

Territorial space: The territory of a state is three dimensional. This basic rule which directly affects all international flight must

never be overlooked. National territory includes surface lands and waters within recognized boundaries, areas below the surface, and space above to a height not yet fixed.

The fact that the extent upward of territorial space has never been fixed exactly in our statutes, or the treaties to which we are parties, presents a problem which demands immediate and pressing consideration now that high-altitude rocket and satellite flight has moved from theory to fact. For every state is supreme within its territory. It can unilaterally determine for itself what foreign aircraft or other flight instrumentalities may enter its territorial space and on what conditions. Its jurisdiction within that area is exclusive and its decisions are final, limited only by such exceptions as it may admit by statute, treaty, or other binding national act.

As Chief Justice Marshall said in 1812—7 Cranch 116—all exceptions—

> to the full and complete power of a nation within its own territory must be traced to the consent of the nation itself.

If the area within which the sputniks operated is part of the territory of the United States, our sovereign rights were violated unless it be that the flights in aid of the Geophysical Year were considered to be agreed exceptions to the prevailing rule of law. These questions must not be left long unanswered. The United States must reach a decision as to its position so that the rules applicable to future space flight will be clear.

The past position of the United States can be briefly stated. And this I would suggest, gentlemen, is history very little known. The United States took a very active part in drafting the Paris draft in 1919 although it never became a party to it.

In Paris in 1919 the United States delegates to the Aeronautical Commission successfully proposed the basic position of the "full and absolute sovereignty of each state over the air above its territories and territorial waters, carrying with it the right of exclusion of foreign aircraft." Later we suggested that the "sovereignty of states extends throughout the atmosphere above their own territories," and finally proposed a draft aviation convention recognizing "the full and absolute sovereignty and jurisdiction of every state in the airspace above its territory."

The terms "air," "atmosphere," and "airspace" were being used interchangeably.

I would like to say, gentlemen, if at any time you desire further information on this subject, I was instrumental in unearthing several years ago in the National Archives here in Washington the original report by the delegates to the Paris convention of 1919 where the documents to which I referred are set out in extenso. They have never been properly annotated. They have never been printed. They are tremendously valuable to anybody studying international air law.

The final text of the Paris Civil Aviation Convention of 1919 contained an airspace sovereignty clause following closely the American draft. We signed, but did not ratify, the Paris convention. However, in adopting the Air Commerce Act of 1926, the United States asserted that it has "to the exclusion of all foreign nations complete sovereignty of the airspace over the lands and waters of the United

States." This is still the law, further strengthened by our ratification of the Chicago convention, which provides that every state has complete and exclusive sovereignty over the airspace above its territory.

The Chicago convention has been ratified by most of the flying nations of the world, with the notable exception of the U. S. S. R. However, the Soviet Government has for may years asserted its airspace sovereignty by statute and vigorously enforced regulations.

When the Chicago convention was drafted, flight in space beyond the lower atsmosphere did not exist. I should add I am referring here to flights of normal types of aircraft. A few months before that, the first V–2 flying bombs, or rockets, had been launched. None of us knew at that time the height to which they operated. The trajectory is now estimated at about 116 miles. I can tell you as a matter of unwritten history, that the effect, if any of the flight of the V–2 on the legal conclusions applicable to flight was not put forward nor discussed at Chicago. And article 1 of the Chicago convention dealing with air space sovereignty, which I had the honor to report out as chairman of the drafting committee, was modeled on the Paris convention. It did not take into consideration the fact that there had been a few rocket flights of V–2's prior to the time of the drafting of the Chicago convention.

No factual basis existed for any determination as to whether states in the international community claimed or could exercise sovereignty beyond areas where aircraft could fly depending on aerodynamic lift. But nothing in the Chicago convention precludes the possibility of state sovereignty being extended upward by international agreement or by unilateral force beyond the "airspace." Nor does the convention define what is meant by "airspace."

The United States must face the fact that until the upper boundary of its territorial space has been fixed, and the status fully determined of the area beyond, all future plans for space flight will run the hazard of serious international complications. Any National Space Agency will be directly involved.

Various suggestions have been put forward as to the boundary to be fixed between the territorial space and areas beyond. Some will lead to international chaos. Included in this category are the ideas that no agreement should be made and that each state may claim territorial rights upward as high as it may exercise sufficient command to make its laws effective. The world will then return to the theory that sovereignty depends on power alone—a disastrous outlook for the future

Personally, I believe that an agreement must be reached as to what is "airspace" in the Chicago Convention and national statutes, or preferably that a new convention be adopted fixing clearly the upper boundary of future territorial space irrespective of what was meant in the past by "airspace".

Such solutions might include an agreement that sovereignty should be limited to the height where all possibility of aerodynamic lift ceases, a height, so I am told, of about 50 miles. This might well be a reasonable construction of the Chicago Convention.

Perhaps a more practical boundary might be at the lower limit of the areas in which a satellite can be put in orbit. Professor Menzel of Harvard, a distinguished astronomer, has stated, at a meeting of

the American Academy only a few weeks ago, that studies of meteors entering the earth's atmosphere indicate that the lower limit of a possible satellite orbit is about 70 miles above the earth's surface, defining an orbit as passage at least once around the earth.

Another suggested solution is that territorial space should be extended upward to include all areas where sufficient drag exists to bring the satellite flight to an eventual end. When the facts are available which are being collected now as part of the Geophysical Year, we will know more as to the upper boundary of areas in which satellite flight may prove a potential danger to the earth below due to atmosphere or other sources of drag. And I would say that some of my distinguished scientific friends feel that there is an area of drag due to perhaps cosmic rays or other things than purely atmospheric drag. It is a very difficult problem even to guess at what the result would be.

If the area of territorial space is extended beyond the upper boundary of aerodynamic lift, consideration must be given to an international privilege of innocent passage for rockets, satellites, and space ships engaged in scientific or other civil functions.

In any event, the United States must consider where its greatest boundary is located, that between its territorial space and areas beyond. The decisions to be reached will be aided by scientific research, but involve grave additional political, military, and legal questions in which any Space Agency should participate.

Outer space: The United States must next consider its position as to the political and legal status of flight in space above its territorial space and above the high seas. This decision, when reached, may well govern a large part of the activities of any national Space Agency.

Strong arguments can be made that this outer space should be dealt with as an area somewhat like the high seas where no single nation may exercise exclusive sovereignty. If such an understanding is reached, it should apply also to the moon and nullify any attempt to seize any part of its surface.

It is impossible for me to accept any decision which says that outer space is not subject to seizure by any state and at the same time says that the surface of the moon may be subject to seizure.

I think there is a complete non sequitur.

One able group has gone so far as to urge that the General Assembly of the United Nations should declare that the international community has title to outer space. This is a very radical suggestion. It would infer, I assume, that some international agency would then be created to determine how, when, and under what regulations any state could use outer space even for peaceful purposes. The inherent political difficulties are immediately apparent.

Another suggestion is that any military use of outer space be banned. This would require an effective international control system. It would, I assume, leave all nations free to use outer space for peaceful purposes subject perhaps to minimum regulations, rules of the road, radio and other communication arrangements, acceptance of national responsibility for damages by collisions or otherwise, and similar provisions. With such an international agreement, man would have a better chance to live in peace.

Even this brief statement shows how vital it is that the United States reach a decision as to its own policy. Careful consideration

must also be given to the question as to whether our course of dealing with our satellite flights and those of the U. S. S. R. has or has not already committed us to the position that outer space is beyond the territorial jurisdiction of any state and is free to all flight. I refer, of course, to the fact that no permission was asked of any state before the satellites were launched, and no protests appear to have been made by any state overflown. If the organization of the International Geophysical Year is deemed tacit consent to the satellite flights without creating precedents for the future, perhaps everyone should be so advised. In any event, a future National Space Agency will be directly affected.

Protective action in outer space by the state below: Years may elapse before complete international agreement exists as to regulation of outer space flight. Even when agreement is reached in theory, experience may show that regulation is not effective in protecting the state below from outer space attack or other danger. In either case, a state below may find itself threatened by the use of outer space above it. If so, has it any right to take defensive and protective action in the areas above and beyond its declared territorial space?

The political and legal aspects of this vital problem should be given urgent consideration. The precedents as to the high seas must be studied with great care. A decision must be reached as to whether principles exist capable of application in outer space.

The rights of national self-preservation and of self-defense are unquestioned. The only problem is whether they are applicable in cases other than definite armed attack.

In 1804, Chief Justice Marshall, in the case of *Church* v. *Hubbart*, discussing protective action on the high seas, stated that the power of a state—

> to assure itself from injury may certainly be exercised beyond the limits of its territory.

In 1914, 110 years later, Secretary of State Root relied upon the same principle as the basis of the Monroe Doctrine, namely—

> the right of every sovereign state to protect itself by preventing a condition of affairs in which it will be too late to protect itself.

I know of no statement of the law that is more accurate in a few words than that statement.

In 1941, President Franklin Roosevelt defended the establishment of defense zones off our coasts before we had entered the war, saying:

> In the waters which we deem necessary for our defense, American naval vessels and American planes will no longer wait until Axis submarines lurking under the water or Axis raiders on the surface of the sea strike their deadly blow first—our patrolling vessels and planes will protect all merchant ships, not only American ships but ships of any flag, engaged in commerce in our defensive waters.

Even more in point is the establishment by the United States in 1950 of the "Air Defense Identification Zone" around our shores. This is curiously very little known. Canada has a similar series of air defense zones.

It is fully conceded that the airspace over the high seas is not territorial space and enjoys the same international status as the high seas themselves. Yet the United States did not hesitate to establish by executive order regulations to prevent unidentified aircraft approaching our shores from the seas. The regulations require among other

things that foreign aircraft must report to an appropriate aeronautical facility when the aircraft is not less than 1 hour and not more than 2 hours average cruising distance via the most direct route from the United States. This is a clear application of rights of self-preservation and self-defense effective outside the territory of the United States and within international space.

Certainly the proposed Space Agency will desire to study these and similar problems affecting the flight of unidentified and potentially dangerous flight instrumentalities over our surface territory but beyond our territorial space.

The examples just given of political and legal questions which are "problems of flight within and outside the earth's atmosphere" as stated in the title of the bills now under consideration—are merely illustrative of the many questions not necessarily included in scientific research. It is respectfully suggested that the functions of the proposed National Aeronautics and Space Agency be widened so as to permit research affecting flight problems other than those which are strictly included as "aeronautical and space sciences." If this is done, the advice of the Agency to other branches of the Government will, it is believed, be made much more comprehensive and useful. Certainly an opportunity will be afforded for a broad, unified analysis of policy affecting both national and international flight within and without the earth's atmosphere.

The CHAIRMAN. Thank you very much, Professor Cooper, for your original statement which is very penetrating and challenging.

We will now hear from you, Mr. Becker.

STATEMENT OF LOFTUS BECKER [36] LEGAL ADVISER, DEPARTMENT OF STATE

Mr. BECKER. Mr. Chairman, on behalf of the Department and on my own behalf, I would like to express my appreciation for the opportunity to appear before you.

I am a native of Buffalo, N. Y. I practiced law in Honolulu and in New York City after my graduation from law school in 1936; and with three exceptions I have merely engaged in the practice of law. One was a departure for the Army during the war. The second was a period of some 2½ years as deputy for intelligence for Gen. Bedell Smith. And finally my present position as the legal adviser of the Department of State.

I said I graduated from law school in 1936. You may have noted that was 2 years after Professor Cooper retired, and therefore, I cannot assume to have the great background and experience he has. My knowledge of the subject on which I am talking today has been acquired through forced feeding in the way they feed geese in order to make their livers somewhat more tasty. I seem to be full of the subject.

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What I shall endeavor to discuss today is first to attempt to correct what I, and I believe my Department, regard as certain misconceptions with respect to international law in the space field, and then so far as I am able to do so to state the position of the Department on some of these matters of international law relating to space.

In doing the latter, I may sometimes sound like the witness who said, "I know nothing, and I shall tell all."

And when I do that, I shall endeavor to give you the rationale of why the Department has not taken a position on some of these issues, although many commentators—and Professor Cooper is not among the number of those commentators—have strongly urged that they do, and have said there is an emergency of some sort in this field.

The first question I would like to discuss is: "Is there any accepted principle of international law bearing upon outer space." I think that there is a great deal of misconception on this point, because I have read a number of articles in which it is stated that the only international agreement relating to space or the atmosphere is the Chicago convention of 1944. And there is no international law with respect to space outside the atmosphere.

Well, I regard that as incorrect because of the specific provisions of article 51 of the United Nations Charter. Under that provision, each of the members of the United Nations reserved their inherent right to defend themselves against armed attack. It is their inherent right of individual or collective self-defense.

Now, the origin of an armed attack against the United States, or the particular point in space through which it would have to pass in order to reach the United States, or one of its collective security partners, is completely immaterial.

The United States is prepared at all times to react to protect itself against an armed attack, even though that attack might originate in territory which is unquestionably subject to the sovereignty of another state.

A fortiori the United States would be prepared to react to protect itself against an armed attack either originating in outer space or passing through outer space in order to reach the United States. And Professor Cooper has already noted the instances in which the United States has stated that it is prepared to protect itself even though the activity threatening the United States is engaged in on the high seas which are common to all nations.

Now, the point I want to make is that if and when the United States takes such action, it is not merely acting unilaterally. It is exercising a right which it has under international law. Because international law in the last analysis is what nations will agree to. And the inherent right of individual and collective self-defense has been agreed to in the United Nations Charter.

Now, secondly, there is another error that I seem to have seen in a number of articles. And that is that we do not have any right to protest or take any action with respect to satellites because of the events relating to the International Geophysical Year. The facts are these: the arrangements with respect to the International Geophysical Year were not made on an intergovernmental basis. They were arrangements made between scientific bodies in a private capacity. It is true that certain governments, including the Soviet Union and the United States, announced in advance that during the Inter-

national Geophysical Year they intended to place objects in orbit around the earth. And it was also stated in connection with those announcements, if my memory is correct, that the purpose of these satellites would be for scientific investigation.

It follows, therefore, that the only conclusion that can be reached with respect to the arrangements regarding the International Geophysical Year—and I should say at this point, as Professor Cooper has already stated, that no nation protested any of these announcements—is that there is an implied agreement that for the period of the International Geophysical Year, it is permissible to put into orbit satellites designed for scientific purposes. Once the year is over, rights in this field will have to be determined by whatever agreement may be reached with respect to such objects.

The third question I would like to call attention to is: Has the United States recognized any top or upper limit to its sovereignty?

Again a number of commentators, other than Professor Cooper, have asserted without qualification that the sovereignty of the United States ends with the outer limits of the atmosphere, and that space outside the atmosphere is either free to all or, as has already been noted should possibly be conceded to be within the sovereignty of one or another international organizations.

Well, the answer to the question I have posed is "No." The United States Government has not recognized any top or upper limit to its sovereignty. And that is entirely aside from article 51 of the United Nations Charter and any limitations that may be inherent in that, such as armed attack.

Now, it is true, as a number of commentators have emphasized, that in such international agreements as the Chicago convention of 1944, the parties thereto recognize that each of them "has complete and exclusive sovereignty of the airspace above its territory."

Now, from this some commentators have inferred a negation of the principle that any state has sovereignty over space outside the airspace above its territory.

I cannot agree that the significance of international agreement upon a principle such as this can be evaluated without regard for the context in which it was made the subject of agreement. To stipulate that a state has complete and exclusive sovereignty within certain limits is not to say that it has no rights above those limits. The only reasonable inference from such a statement is that no agreement has been reached as to what, if any, rights may be recognized above such limits.

It is important to note that there is nowhere in the Chicago convention of 1944 or other international agreements comparable thereto any definition of what is meant by the term "airspace."

A number of those who have commented on what should be the law of space have suggested definitions for this term. I do not wish to take, nor has the State Department ever officially taken, a definitive position as to how this term "airspace" should be defined. I think it important to know, however, that one of the suggestions made in this regard is that the airspace should be defined to include that portion of space above the earth in which there is any atmosphere. I am informed that astronomically the earth's atmosphere extends 10,000 miles above its surface. Just before I came over here this morning I received a phone call in which it is reported that there is

an article in the Times this morning in which one investigator claims there is evidence of atmosphere anywhere from 40,000 to 200,000 miles away from the earth's surface.

Well, while we haven't taken any position on the question, I think you will appreciate from these facts that it would be perfectly rational for us to maintain that under the Chicago Convention the sovereignty of the United States extends 10,000 miles from the surface of the earth, an area which would comprehend the area in which all of the satellites up to this point have entered.

At any rate that type of definition would afford us enough elbowroom for discussion.

Now, it is also important to note that although the United States in its domestic law, as well as agreements such as the Chicago Convention, has plainly asserted its complete and exclusive sovereignty over the airspace above its territory, it has at no time conceded that it had no rights in the higher regions of space.

One rationale for this position which seems to me self-sufficient was that the United States had no need to define its position with respect to what rights, if any, it might possess outside the earth's atmosphere until such time as mankind had demonstrated a capability of existing outside the atmosphere.

Even after such a capability is demonstrated, there will be no imperative requirement in international law that the United States make any claims of sovereignty in order to protect its rights.

A very apt analogy is afforded by the Antarctic. There, for many, many years, the United States has been engaged in activities which under established principles of international law, without any question whatsoever, created rights upon which the United States would be justified in asserting territorial claims. That is to say, claims to sovereignty over one or more areas of the Antarctic.

Notwithstanding this fact, the United States has not asserted any claim of sovereignty over any portion of Antarctica, although the United States has at the same time made it plain that it did not recognize any such claims made by other states.

Nontheless, the United States has been consistent in asserting that under international law and practice its activities in the Antarctic Continent have entitled it to rights in that area which it has at all times expressly reserved. It is the position of your Government, and I believe one well founded in international law, that the fact that the United States has not based a claim of sovereignty over one or more areas of Antarctica, upon the basis of the activities it has engaged in there, in no way derrogates from the rights that were established by its activities.

So, too, in outer space the United States has already engaged in activities which, it could be asserted, have given to it certain rights and distinguished from those states who have not engaged in such activities. Up to this time, the United States has made no claims of sovereignty based upon such activities.

As in the situation with respect to Antarctica, this should not be interpreted as any concession of any kind whatsoever on the part of the United States that its activities have not given it certain rights in space which in turn could be relied upon as the basis of a claim of sovereignty.

Now, I would like to turn to the question of whether or not the law of space should be codified at this time. I may say in that connection that I returned very recently from Geneva, Switzerland, where 82 nations were engaged in an attempt to codify the law of the sea.

Now, man has been traveling on the sea for thousands of years. And a certain number of rules with respect to travel on the sea and what might be done there have been well recognized in international practice for hundreds of years. The conference lasted for 10 weeks. It was the subject of the most bitter negotiation that I have ever seen. This is with respect to an area of international law where many, many facts are known.

Now what has been done with respect to the law of space up to this date by this country?

The President, the Secretary of State, and Ambassador Lodge in the United Nations, have several times suggested—and they sometimes made the suggestion directly to the U. S. S. R., which to date is the only other state that has demonstrated a capability of placing objects in orbit in space—that we consult with the objective of insuring that mankind's activities in space be devoted exclusively to peaceful purposes. These proposals have included any and all activities in space, whether or not they involve putting an object in orbit.

To the extent envisaged by these proposals, we believe that the sooner that agreement is reached, the better.

As you know, the development or the tendency of development of the common law as it is applied in the United Kingdom and the United States and a number of other countries has been on a case-to-case basis.

Speaking very generally, it has been felt that the soundest way to progress in the extremely complex field of the law is by means of specific decisions on specific questions presented by specific fact situations. Even in those states which applied the principles of the civil law, it is recognized that a body of law can only be created upon a broader body of ascertained fact.

Moreover, there are very great risks in attempting to transmute a body of law based upon one determined set of facts into a body of law with respect to which the basic facts have not been determined.

Accordingly, we are inclined to view with great reserve, any suggestion that the principles of the law of the sea should, prior to the ascertaining of many more facts with respect to conditions in space, become the law of space.

Basically it is the position of our Government that the law of space should be based upon the facts of space, and that there is very much more that we have to learn about the conditions existing in space before we shall be in a position to say what shall be the legal principles applicable thereto.

Now, let me speak for a moment on the significance of a definition of the airspace. It has many times been suggested that it is imperative that at the earliest possible moment we shall have an internationally agreed upon definition of airspace. This is related to the suggestion that such definition is requisite in order to delimit areas of national sovereignty. I believe from what I have already stated it will be apparent to you that I do not share in this view, nor

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has the United States Government ever conceded that its sovereignty upward was restricted to the airspace above its territory.

There are other aspects of this question with respect to which the significance of this dividing line may be less important than has heretofore been asserted. Public announcement has been made of an X-15, which is designed to operate both inside and outside the earth's atmosphere as defined, at least, by some of the commentators. Moreover, all objects which orbit around the earth, whether they do so within or outside the atmosphere, or partly within and partly outside the atmosphere, have characteristics of operation which distinguish them sharply from other objects which may, for a period of time, pass through space.

As you are undoubtedly well aware, a number of systems of private law relate to the characteristics of the activities upon which one is engaged.

For example, in our own law we have one set of rules applicable to the activity of mining; another applicable to the extraction of petroleum and like materials; and still another applicable to subsurface waters; although all three activities in general relate to man's actions or interests below the surface of the earth.

Here again, one of the possibilities to which we shall have to give serious consideration is whether the performance of a particular space vehicle is sufficiently distinguishable so as to justify applying to it a set of rules which are different and distinct from those we apply to other space vehicles having different operating characteristics.

To take an analogy from the law of the sea, while there have been certain principles applicable to all seagoing vessels, there has always been a distinction between the rules applied to sailboats and those applying to boats propelled by one or another method of mechanical propulsion.

Another issue that has been raised with respect to space is the status of property rights there. A number of commentators have stressed the necessity of developing some internationally recognized set of principles of property rights applicable to space vehicles. Two of the questions frequently raised are, first, as to the right of the state beneath—the subjacent state—to protect itself from injury from such a vehicle landing on its surface or its inhabitants, or, second, as to the right of such a state to damages for injuries resulting from such activities.

Another question in this regard which received a certain amount of attention in the press when the Soviets claimed that a portion of their Sputnik No. 1 had landed in some unidentified portion of the United States, is whether or not the state which initiates the flight of a space vehicle retains a property right in that vehicle in the event that it comes to earth again.

Now, even though there isn't any generally accepted international code regarding space vehicles as such, I would suggest that existing international law and domestic law provide a set of principles which could be considered as applicable until such time as we find it necessary to recognize specialized principles.

With respect to the right of a satellite or a missile to pass through the airspace of the United States, we have to take account not only of the Chicago Convention and its definitions of "aircraft," but also the domestic law of the United States and its definition of "aircraft."

In our domestic law, just as in the Chicago Convention we assert complete and exclusive sovereignty over the airspace above our territory. Now the definition of aircraft in our domestic law is considerably broader than that contained in the Chicago Convention because both in section 9 of the Air Commerce Act of 1926 and in section 1, subsection (4), of the Civil Aeronautics Act of 1938, aircraft is defined as follows, and I quote:

> Aircraft means any contrivance now known, or hereafter invented, designed for navigation of or flight in the air.

As you can see that is an extremely broad definition—"designed for navigation of or flight in the air."

By that apposition, the indication is that you can navigate in the air without flying in the air in the sense of being suspended by the air.

I would take the position that that provision, regardless of any provision of the Chicago Convention, would cover a missile or any object regardless of the method of propulsion.

Accordingly, our domestic law would apply as to transit of our airspace by any such object. We have made it perfectly plain that other nations are not entitled to invade that airspace without the consent of the United States Government.

Assuming that the problem of reentry has been overcome, so that a space vehicle does not disintegrate before it returns to earth, such a vehicle must, of necessity, pass through the airspace of the United States in order to return to earth if it comes in over the geographical area of the United States, or over our territorial waters

It is a recognized principle of international law that the sovereignty of a state with respect to the airspace over its territory and its territorial seas is complete and exclusive. That means that the vessels of another state, including those which are unmanned as well as those that are manned, are not entitled to enter upon such airspace without the permission of the sovereign state.

If the permission of the subjacent state is to be obtained, it may be conditioned by undertakings with respect to liability for any damage that may result therefrom.

If it is not obtained, the tortious nature of the entry upon the airspace of the subjacent state would seem to make the initiating state a guarantor with respect to any damage resulting from its unjustified activity.

As respects the ownership of a space vehicle returning to earth, some commentators have suggested that at least as respects unmanned space vehicles, the appropriate analogy is a bullet; ownership of which is abandoned by the act of firing. An alternative rationale would be that any such vehicle entering the airspace of a sovereign state without the latter's permission should be placed in the category of smuggled goods which may not only be confiscated upon discovery but with respect to which action may be taken outside the territory or the territorial waters of the state in which they are to be introduced.

I refer there to the type of precedents that Professor Cooper referred to, that we reserve the right before an object or vessel has entered within our sovereign area to take measures to see that it does not so enter.

Thank you, gentlemen.

The CHAIRMAN. Professor Cooper, on your first page I note you said, "The powers given to the space agency should be sufficiently broad to encompass these objectives."

And on your last page, page 10, it is respectfully suggested that the—

> functions of the proposed international aeronautics and space agency be widened so as to permit research affecting flight problems other than those which are strictly included as "aeronautical and space sciences."

What language do you suggest could be included?

Mr. COOPER. I simply put that before the committee as consideration for a principle. I have no language to suggest.

I had a conflict in my own mind, having been a scholar and having been a rather technical lawyer at times. As a scholar, if I were acting as counsel for such a space agency, I would certainly wish that space agency had a reasonable opportunity to investigate cognate problems merely in addition to pure scientific questions.

As a technical lawyer, I was rather afraid that the language in the bill under the heading "Functions" delimited rather strictly the power of the space agency, and that some challenge might be given as to its right to expend funds for any research that was not pure or applied science. I simply wanted to bring that before you from my own personal point of view as something the committee might want to consider.

Mr. FULTON. We have the bill right here.

Mr. COOPER. I can point out the section.

This is the bill 11881. It was the provision appearing on page 5:

> The agency shall develop a comprehensive program of research in the aeronautical and space sciences, (2) plan, direct, and conduct scientific studies and investigations of the problem of manned and unmanned flights within or outside the earth's atmosphere with a view to their practical solution.

It seemed to me that both of those phrases were somewhat narrower than the declaration of policy which said that the general welfare and security of the United States required the adequate provision to be made for research into and the solutions of the problems of flight within and outside the earth's atmosphere.

That is much broader language than the functions which I, as a lawyer, thought had been delegated to the agency.

That, however, is a matter, sir, on which I would not consider myself an expert. Perhaps I am entirely incorrect, but I did wish to bring it to your attention.

The CHAIRMAN. You recognize, of course, like Mr. Becker, that this is a matter of long-range study, consideration, and action.

Mr. COOPER. That is exactly my point, sir. It seems to me there are problems in addition to those of pure science which are involved.

The CHAIRMAN. And Mr. Becker has in his statement properly tied up the whole question to security of our country.

Mr. COOPER. I agree. That was the purport of Mr. Becker's testimony, as I heard it.

The CHAIRMAN. As I analyzed your views and Mr. Becker's views, representing the State Department, there isn't much basic difference.

Mr. COOPER. I would say, sir, that I have had the pleasure of discussing these problems with Mr. Becker many times. I think our views are strikingly similar.

Mr. BECKER. I concur in that statement.

The CHAIRMAN. How did the Paris Convention and Chicago Convention come into being? Was that governmentally sponsored?

Mr. COOPER. The Paris Convention, sir, was an outgrowth of the Paris Peace Conference. In 1910 there had been an effort in Europe to draft a convention for the international regulation of civil flight. That conference drafted an almost complete convention. It broke down on some rather technical disputes between the German and the British delegation as to whether or not different rules could be made applicable by the state below for its own aircraft and foreign aircraft. Both the French Government and the British Government, during the war, did a great deal of work on the question of international control of flight after the war.

When the peace conference assembled in Paris, it was decided to assemble an aeronautical commission to deal not with the problems of the peace treaties, but to deal with the future control of international flight after the war. The United States delegates were two distinguished officers, one naval and one military. They had had no prior warning that this commission was to be set up. It is purely amazing the work that this hastily assembled delegation did.

And as I pointed out in my statement, they took a very active part in the determination of principals which should be applicable to civil flight.

One member of the American delegation was actually on the drafting committee which brought in the Paris Convention. The Paris Convention was signed by practically all of the Allied Powers, including the United States.

From statements made to me by a long-deceased member of the Senate, there are two reasons why it failed of ratification. The ordinarily assigned reason is that it referred indirectly in the convention to operations under the League of Nations, or something like that. In other words, it was tied up to some extent with the League of Nations.

The direct technical question which I mentioned this morning, so I was told by the then chairman of the Foreign Relations Committee, was that—I am trying to remember the name—who was the Senator from Nevada who was chairman of the Foreign Relations Committee for years.

Mr. McDONOUGH. Senator Pitman.

Mr. COOPER. Yes. He told me personally that the major reason, in his judgment, why the Foreign Relations Committee didn't accept the Paris Convention was that it constituted a delegation to the international regulatory body set up under the convention power to amend the annexes. And the annexes in the Paris Convention were part of the convention itself.

The Chicago Convention was drafted at an international diplomatic conference held in Chicago called by the United States at which were present all of the Allied Powers and a number of neutral powers. There was a long discussion in the United States delegation about this very point that I have just mentioned. And it was for that reason that the United States took the very vigorous position that the annexes to the Chicago Convention were not to be considered as part of the convention, namely that the International Civil Aviation Organization was not being delegated power to amend the convention without its being reratified by the United States.

I am not sure that that is material here, sir.

The CHAIRMAN. In other words, it might be a guidance to such nations as wanted to be guided by it, in whole or in part.

Mr. COOPER. There are very elaborate provisions applicable to the International Civil Aviation Organization under which they adopt annexes and distribute them to the member states. And they request that member states within a certain number of days, advise them whether they reserve on any of those provisions.

The CHAIRMAN. On page 6 you stated that "an agreement must be reached as to what is 'airspace' in the Chicago Convention and national statutes, or preferably that a new convention be adopted fixing clearly the upper boundary of future territorial space irrespective of what was meant in the past by 'airspace'."

Was the establishment of the Paris Convention on a governmental level?

Mr. COOPER. Yes. With reference to article 1 of the Chicago Convention which is the airspace sovereignty clause, it was copied almost verbatim from the Paris Convention. And the reason it was done was this: There was already a lot of international flying, military and otherwise, and some international agreements, prior to World War I. Some of the people at Chicago felt—and I concurred—that if we put new language as to state sovereignty in the Chicago Convention that had not been in the Paris Convention, someone will say, "What is the meaning of these changes?" and therefore, unanimously the Chicago Conference accepted the sovereignty statement in article 1 of the Paris Convention, which is a very interesting document.

It says, Mr. Chairman, that every state—not every signatory state—but every state has complete and exclusive sovereignty in the airspace over it. Which means that they accepted and approved an already-prior existing rule of customary international law—they said we are simply saying that every state, irrespective of this document now has sovereignty, complete and exclusive in the airspace.

It was not a mutual exchange, a grant of new rights and privileges. It said just as Paris said, "every state has." The Paris Convention used the old terminology that "every power has." We changed it in Chicago to "every state has."

The CHAIRMAN. In other words we all agree. But we have the individual right of veto?

Mr. COOPER. I think, sir, that everybody agrees there is sovereignty in the airspace. My worry is "what is the airspace?"

The CHAIRMAN. Well, I am not passing on the enunciation of that principle. But I mean that carrying it into operation gives to every nation the right to its own action.

Mr. COOPER. I would say, sir, that the very few states which have not ratified the Chicago Convention have similar language in their own statutes. For example, the U. S. S. R. has had since about 1921 very strong statutory statement that the U. S. S. R. claims sovereignty.

The CHAIRMAN. Of course in connection with any such conference or international meeting, the State Department, of course, would play a very important part in connection with our Government.

Mr. COOPER. I would say, sir, that I have had the pleasure of assisting the State Department in some past years. And I know that it has always had these matters in mind.

I would think it unfortunate if any department, but the State Department, had the final say-so.

The Chicago Conference was actually called by the President at the request of the Secretary of State.

The CHAIRMAN. So that while the new space agency might have a place therein, it would be naturally secondary to that of the State Department.

Mr. COOPER. Certainly, sir.

The CHAIRMAN. Now, I notice on page 6 of your prepared statement, you mention the theory that no agreement should be made and hence each state may claim territorial rights up as high as it may exercise sufficient command to make its laws effective. The world would then return to the theory that sovereignty depends on power alone—a disastrous outlook for the future.

In part, if I read your mind correctly—and if not, I wish you would clarify it—I would infer that one of the thoughts running through your mind is that we are entering into some new adventure. Some of the things that can be accomplished we know. Others we don't know. So if any international agreement can be made on utilizing space for peaceful purposes, the attempt should be made before any two or more nations get into a serious competition on the military level for the use of space for military purposes.

Would that be a fair inference?

Mr. COOPER. That is entirely fair, sir. I argued this point at some length a number of years ago, pointing out that if you accepted the theory that sovereignty ran as high as you could grant, the small states would never have any future use of space, and you would have a competitive world that personally I would dislike as a peacetime operation.

The CHAIRMAN. What importance do you attach to the establishment of a space agency in our Government giving it adequate powers on a high decision level, the power to carry out decisions? What importance do you attach to such an agency?

Do you think we need one?

Mr. COOPER. I would say, Mr. Chairman, that I had an indirect part in the conferences out of which the Civil Aeronautics Act of 1938 grew. I happened at that time to be a member of the industry committee which was discussing those problems with the Government. I feel about this problem much as I did then; that regulation on a sound basis for such an evanescent thing as flight is highly advisable.

Also I feel that the problems of the peaceful use of space—a problem in which I am primarily interested—I have no military connections—that the United States could, by organizing such an agency as I read in your bill, put itself in the position to think a long way ahead of how the United States and man generally could take advantage properly of this new method of transportation without engaging in what I would deem unfortunate and maybe catastrophic international competion.

I think that this space agency could analyze the entire field and say, "Well, perhaps the time has now come." And I will give you a concrete example.

Such an agency, a space agency, might say, "Perhaps the time has now come when we can carry the mail rom New York to London by rocket. If so, why not do it?"

In other words, I think that you have a whole new problem to deal with. And I think that a new agency could very aptly do it provided,

of course, that it is worked into the general framework of our rather complex Government.

The CHAIRMAN. Have you any opinion as to whether a new agency should be on a commission form or a single head.

Mr. COOPER. I have none whatsoever, sir.

The CHAIRMAN. Both of you gentlemen, as all other witnesses, have permission to edit your testimony. Upon looking over, particularly, your extemporaneous answers and questions you might want to clarify. You have permission to do so.

And if you have any language you want to suggest in connection with what I have referred to on page 1 and page 10 of your testimony, we welcome any such suggested language.

Mr. COOPER. Thank you very much, sir. I will discuss that matter with Mr. Feldman, your counsel, and perhaps I might have some suggestions to make.

I have none in mind at the moment.

The CHAIRMAN. Mr. Hays.

Mr. HAYS. I believe I will direct my questions to Mr. Becker, since the question is inspired by his testimony. Professor Cooper will probably want to make a comment on it.

First, let me say that your statement was exceedingly helpful. The committee, I am sure, all appreciate the study you have given to this problem. And it is very enlightening to me. Now, as I understand it, the Chicago Convention—its usefulness in this situation is limited somewhat by the fact that they were contemplating only control of airborne vehicles.

Mr. BECKER. That is a construction of their definition of aircraft. It does not specifically limit it to airborne vehicles, although it might be argued that it should be so construed.

Mr. HAYS. Do you mean that rockets were not necessarily out of mind—that is, speaking of airborne, the power or propulsion, depending on the presence of atmosphere. The rocket that went outside the atmosphere was just not in the contemplation of the Chicago Convention, was it?

Mr. BECKER. Well, I don't know the answer to that question, sir. If you recall, the convention was entered into in December of 1944. In September of that same year, the Germans had begun firing the V–2 rocket, which went, as I understand it, about 115 or 116 miles out from the earth before it returned to the earth. And as you also recall, there was a remarkable degree of publicity with respect to that fact inasmuch as they were landing on London. So they could have had that type of thing in contemplation. It is possible they did not. The language they used was certainly not as good as the language that is used in our domestic law in that regard.

Mr. HAYS. I think your answer proves very well the complexities of this whole problem. I anticipated there would be a categorical answer. I hadn't realized that you had that basis for the answer.

At any rate, it is fair to say that there is some help in the experience of the Chicago Convention in these problems.

Mr. BECKER. That is right.

Mr. HAYS. But we have to assume for administrative purposes and for legal purposes that a new beginning would be substantially necessary.

Mr. BECKER. I concur in that statement, Congressman Hays.

Mr. HAYS. For the reasons we made?

Mr. BECKER. Yes.

Mr. HAYS. One deals with the area covered by the blanket of air, and the other outside.

Mr. BECKER. I not only agree with that, but as you may have gathered from my statement, I recommend that we approach this problem as an entirely new problem and make our decisions on the basis that we have a completely new set of references to deal with.

Mr. HAYS. The Soviet Government is a part of the Chicago Convention.

Mr. BECKER. No, it is not.

Mr. HAYS. Has there been any overture to them to become a part of it?

Mr. BECKER. I am aware of none.

Mr. HAYS. That means, then, that there are no Communist governments a party to it?

Mr. COOPER. Mr. Hays, if I can give you some past history: When the Chicago Conference was called by the Secretary of State, the Soviet Government accepted the invitation to attend the Conference. Its delegation was actually en route by air to the conference and had reached a point somewhere in Canada, en route to Chicago. I remember very vividly sitting in a meeting in the State Department of the United States delegation preparatory to our going to Chicago, when we were advised by one of the assistant secretaries that they had just been notified the Soviet delegation had been recalled and would not take part.

So, they were invited by the United States originally to take part, but did not actually participate in the Convention and have never signed it.

Mr. HAYS. Thank you very much. I was impressed by what you had to say about treating space law as distinctive from sea law. And it is true, isn't it, that international law with reference to the sea tends to become rather rigid. How is international law changed and what will we run into in this matter of law governing space with reference to amendments?

Isn't international law very difficult to change? You have no legislature to change it.

Mr. BECKER. I will give you a very good example of that, Congressman. And it comes out of this Geneva Conference on the law of the sea. Certainly by the end of the 19th century, it was very well settled that each state had a territorial sea in which it could exercise sovereignty out 3 miles from its coast. Since that time a number of nations have made broader assertions unilaterally as to their right to have a territorial sea having a broader area.

Some have claimed 6, some claimed 12, and some have claimed up as far as 200.

One of the basic issues at Geneva was whether or not that 3-mile rule should be changed; because unless there was agreement to change it, it would not be changed, and the United States has consistently taken the position that notwithstanding the fact that, oh, some 25 percent of the nations claim a broader territorial sea, that is not effective to make a change in the customary international law.

We received a vote of 45 to 33 to a compromise proposal made by the United States at Geneva under which there would be a 6-mile

territorial sea with a contiguous 6-mile zone in which the coastal state would have the exclusive right to control fishing, subject, however, to the historical rights of those who had fished in that outer 6 miles for the last 5 years.

We had a majority—45 to 33—but the rule of the conference was that no principle was adopted unless by two-thirds vote.

As a result, and notwithstanding the proposals that were made there, we have made it plain that we regard the 3-mile territorial sea as international law as of this date. Had two-thirds adopted, or had two-thirds voted in favor of that compromise proposal, then in turn that convention would have been brought back for ratification by our Senate and by the other parties to the Convention.

And if you have, say, two-thirds of the nations of the world—that would be two-thirds of 82 nations—agreeing that there had been a change in the international law, I think you would have a reasonable chance of getting the International Court of Justice to hold that that had accomplished a change.

Mr. HAYS. Thank you very much. Now I have one other question. This may be—it may appear to be a bit fanciful—but it relates to the common-law reference to the ownership of property.

There was an old statement that the owner of a part of the land owned to the center of the earth and to the top of the sky. Going down he knew he could own no farther than 4,000 miles, half the diameter of the earth. And when the phrase originated "to the top of the sky," no one had any idea, I presume, that the sky meant farther than a few miles.

But that, did stand for centuries at least—the rule. It is conceivable since space broadens the farther you go that a fellow, if he did own to the top of the sky, would own a planet out there; if that were theoretically accepted.

Mr. BECKER. He would have to share it with an awful lot of people because the earth is rotating. And he might own it for a fraction of a second while the earth turned around and his plot happened to be beneath the planet.

But a great number of other people in a ring around the earth would have an equal claim of right.

Mr. Hays. I am glad I asked it, because that disposes of my question. But wouldn't that be equally true when you apply it to sovereignty?

The only way we could assert sovereignty in outer space, projecting our earth area into space, is by exploration and discovery; isn't that true?

Mr. BECKER. Well, there seem to be two parts to that question. Let me turn to the first part.

Sovereignty in that type of a context might be defined as the "power to exclude." So that even though you were moving underneath and a constantly changing spot in space, because of your sovereignty, even temporary, over there, you had a right to exclude at least for the period that it was over your particular sovereign territory.

I might add that exactly what constitutes exploration or appropriation of space has not finally been determined. I am not a scientist, but I do understand that it might be technically feasible to put a satellite in orbit which bore such a relationship to the rotation of the earth, which in respect to a spot on the earth's surface would remain

immovable, and, therefore, you might have an instance of where you would have a Washington satellite, let us say, with men on board. It would all depend on the scientific possibility of that existing.

But I don't think we can exclude any of the possibilities in thinking of this problem.

Mr. HAYS. Professor Cooper wanted to comment on that.

Mr. COOPER. I simply want to amplify what has just been said. My scientific friends tell me—I explored this problem that has just been raised—that it would be possible to put a satellite in orbit over the Equator at 22,000 miles up. And if then it would be moving in the direction of the rotation of the earth, it would appear to be a fixed object.

There seems to be doubt as to whether or not a so-called fixed object satellite can be set up otherwise. This is thirdhand, but from two very able scientists with whom I discussed the matter.

I would like to amplify just one other problem that was raised.

If you put a rocket aimed into outer space with an initial velocity of approximately 25,000 miles an hour, it can, in theory, move outside the area of the earth's gravitation and get into what is really outer space. But to show you the difficulties of attempting to control any such parts of far-distant space for the purpose of making law effective, by the time that rocket got to the edge of the last gravitational pull, it would have taken about 6 hours to get there, and the earth would have moved one-quarter around, and you would be shooting into and controlling someone else's space if you tried to use this theory of projecting sovereignty indefinitely into space.

There are all kinds of problems.

And may I answer the chairman's question again: It is questions of such a nature which require a great deal more thought and study, and which I think such a space agency could well consider.

Mr. HAYS. Do I understand that as the law now stands, whatever law we can apply to this situation, it is legal to move across another sovereign state's area only a nonmilitary satellite?

Mr. BECKER. Well, there are two points. It has never been expressly recognized by this Government or, as far as I am aware by any Government, that another state has the legal right to put even a peaceful satellite over our territory.

The only thing that you can say is that you might infer an implied consent by the failure to protest the satellites that have been put up at this point.

I think it would be fair to say that if anybody attempted to put up a military satellite which had any offensive capabilities with respect to the United States, that this Government would take the position that that was not legally permitted.

Mr. HAYS. But as you said, we have the right reserved to all nations to defend ourselves. A defensive operation is different from an offensive operation in legal terms as well as military. But then on the other point I had understood there was some concession in the arrangements for the International Geophysical Year. There was that understanding; by concession.

Mr. BECKER. What I meant to say with respect to those arrangements is, first, they were not made on a governmental basis. We did not agree with other governments on it. It was made by the scientists, as citizens, international though they were. They were not govern-

ments. And, second, the only thing we have actually stated with respect to the satellites is the announcement of our plans to put them up and recognition of the fact, that there is an implied consent for the ones that have gone up to this point.

Mr. HAYS. Thank you, Mr. Chairman.

The CHAIRMAN. I would like to have both of you gentlemen put in the record first, if it is a one-man agency, the type of man you think should be appointed. His qualification. And if it is a commission form, the type of qualification of those who should comprise the commission.

If you have any thoughts now you can express them.

Mr. COOPER. As I read the bill, sir, at the present time, it provides for a technical director who is vested with most of the powers and a board that has advisory powers, the present bill seems to be a combination of those two thoughts.

Perhaps I have misread the bill.

The CHAIRMAN. The Director is the head. Under the NACA now, the Board is the real operating head. But this puts the Director at the head, with the advisory board advising him, but probably having some implied power more than advisory. This is because they have to be consulted before certain things are done.

That carries with it certain implications which you and I are aware of.

Mr. COOPER. As I take it, sir, the Director is not a member of the Board as it is now set up.

The CHAIRMAN. That is correct.

Mr. COOPER. A different situation might arise if the Chairman of the Board were also Director, would it not?

The CHAIRMAN. Well, I would think that any bill drawn up, if it were a commission form, for example, would probably provide for the operating director.

Mr. COOPER. I am sorry, sir. I stated it badly. As I understand it there is a clear distinction made in this bill between the Chairman of the Board and the Director.

The CHAIRMAN. Oh, yes, the Chairman of the Board is one of the 17 advisers appointed by the President; 8 of whom will be in Government; 9 outside; and the Chairman shall be one of the outside advisers designated by the President.

So, in reviewing your testimony, will you give us an idea of the type of a man whether he is director, administrator or commissioner—or in the case of a commission, the type of men, who should comprise the commission.

Mr. BECKER. It is my personal view that the individual appointed to either position should possess generally the qualifications requisite for appointment to a senior administrative position in the Government, such as a Cabinet member, departmental head, or member of a major agency such as the Atomic Energy Commission. While technical knowledge is desirable, the choice should depend basically upon demonstrated judgment and administrative capability, rather than specialized qualifications.

Mr. COOPER. A one-man agency should be a civilian of Cabinet caliber—experienced in administration, with significant scientific background, but with a broad point of view, a commission ought to include men with military, scientific, international affairs and legal backgrounds.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Gentlemen, I want to thank you for the fine statements you both made to our committee. I would like to direct one question to Mr. Becker.

Assuming that our satellite procedure up to the present time violates no provisions of our laws that will cause us any trouble, what is going to happen, Mr. Becker, if we are unable to agree with the Soviet Union, and we have no codification of our law concerning this particular matter at the close of the Geophysical Year?

This bill, as you know, provides for research and problems of flight within and outside the earth's atmosphere.

What will be the policy of the State Department? What should be the policy of the State Department? And where do we proceed and how do we proceed at the close of this Geophysical Year?

What do you gentlemen say to that?

Mr. BECKER. Well, I think that the State Department, like the President, and like Ambassador Lodge, has already taken a position on that point. And that position is that we are urging the only other country that presently has a capability in the area with respect to which it arises—we are urging the Soviet Union to get together with us and agree that this shall be devoted to peaceful purposes.

Now, I would assume that when you came together to make such an agreement, you would at the same time define what were peaceful purposes and agreed-upon uses.

So you would automatically have, if we once get together to talk about this thing, a start from what we think is the focal point—trying to keep warlike things out of this brandnew area.

Mr. NATCHER. Mr. Becker, assuming no agreement is reached, we have no codification of our law concerning outer space and space generally; how are we going to proceed at the close of the present Geophysical Year?

What suggestions do you have to make?

Mr. BECKER. Well, Congressman Natcher, I think we would make that determination in a specific context. In other words, we would decide what we wanted to do, what we thought it was in the interest of the United States to do; and then we would take action accordingly. I don't like to answer that type of a question in a generality. It is a little too unspecific to deal with.

I would point out that we have already in one instance tackled that problem directly. A number of nations are presently engaged, again by the same type of vague agreement, in scientific work in Antarctica. There has been no agreement as to what to do after the International Geophysical Year. And just the other day you will have noted we sent out a note to the 11, I believe it is, nations which are either engaging in work there or otherwise have a direct interest in Antarctica. We are urging them to come together and sit down with us and work out some type of an administrative agreement to enable that work to be carried on in an orderly manner without having any conflict on sovereign rights or anything of that sort.

The suggestion we have made in that instance is that we reserve all our rights for the duration of that particular agreement. No activities that anybody may engage in that area will give them any additional rights.

There is one example where we have tackled that problem directly.

Mr. NATCHER. Professor Cooper?

Mr. COOPER. Being here as a private citizen, I would not for a moment indicate what I thought the Government's position should be. I will say this, however, that if I were a member of this space agency, one of the first things that I would do would be to say that this is the primary problem to be studied immediately.

Mr. NATCHER. Thank you, Mr. Chairman.

Mr HAYS Mr. Sisk.

Mr. SISK. I am sorry I missed the early part of your statements. I have been attempting to read your statement here, Professor Cooper.

Before we could put what I will term "communication satellites in space," under the several proposals we have had before us, and, where you space, say, three satellites in an orbit for mass television or other types of communication, then this whole legal question is probably going to have to be—well, not necessarily solved—but at least some type of international agreement will have to be reached before we could, with freedom, proceed to that type of operation.

Is that your understanding?

Mr. BECKER. That is not my understanding, Congressman Sisk.

There are a number of areas in which various nations have taken action, even though their respective legal rights were by no means settled.

In Antarctica various nations have made claims of sovereignty in areas where we have engaged in activities which in our view gave us rights. We have continued to take action in Antarctica, even though we have not conceded their right, nor have they conceded anything with respect to our rights.

It is a case where we have gone ahead and acted, even though the legal situation was not at all clear. That has been going on for 20 years without any difficulty.

Mr. COOPER. If I may amplify a little.

This may be one of the very few points on which Mr. Becker and I may not be entirely in accord. I am not as young as I once was. And I find I get more conservative each year that goes by.

It seems to me, sir, that if there is no understanding—and this is exactly the point that has been raised—if there is not understanding as to the legal status of outer space by the time the Geophysical Year ends, you may have a fruitful possibility of international misunderstanding when new types of satellites are launched.

Mr. SISK. The point I wanted to try to clarify in my own mind—and I think it is all-important with reference to the proposed new space agency—is whether we can move into even peaceful uses of this area—weather observation, communications, and so on? Are we going to be held up possibly? I don't know how fast we are going to move in this area, but with proposals we have before us, we could move rapidly into it. Are we to be held up by a matter of international law or international agreement?

I note your statement, your first paragraph on page 6 there with reference to the fixing of territorial space. And this struck me particularly. Where you say:

> Included in this category are the ideas that no agreement should be made and each state may claim territorial rights up to as high as it may exercise sufficient command to make its law effective.

And I agree with this:

> The world will then return to the theory that sovereignty depends on power alone—a disastrous outlook for the future.

If we proceed on that basis, then to me justice and equity in the world will have ceased to exist. It will become simply a matter of power and power alone, and probably will finally be dominated by a single power.

As I understand it, there is some disagreement—I am not trying to create a conflict between you gentlemen—as to how far we may proceed in these peaceful pursuits until there is some type of understanding by nations of the world in the use of this area.

Mr. BECKER. Congressman, I am not prepared to concede that the nations of the world as a whole have a veto power upon our right to engage in activities in space. There are a great number of nations in the world today—there were 82 attending this Conference—many of them are very new nations; many of them have very little experience in this field; many of them might well take the attitude if we attempted or recognized that they had a veto power that maybe the best thing for us to do is to take our satellites and go home.

I do not want to recognize that principle.

Mr. SISK. Then, I would assume that you would take the position that neither would we, as a sovereign power, have the right of veto over any other nation to engage in like pursuits.

Mr. BECKER. I would determine that question, and that is the way in which the Department would determine it, in a specific context.

What did we want to do? Did we think we had the right to do it under the circumstances then existing, whether or not there was an agreement.

What does another nation wish to do in that area? Do we regard that, under the circumstances then existing, as contrary to the interests of the United States. If we do there are a number of things that we could do.

Mr. SISK. Professor Cooper.

Mr. COOPER. You have put your finger on the most difficult problem that I think exists in this whole area. The very basis of the status of territorial sovereignty is that the sovereign state has a complete veto power, if you chose to use the word "veto," on what foreign activities take place in that area.

As a matter of fact, if you will note when I described the background of the Paris Convention, I called attention to the fact that the United States delegates stated the primary principle which was accepted as the basis of the Paris Convention, namely, the full and absolute sovereignty of each state over the air above its territories including territorial waters, carring with it the right—not power—the right of exclusion of foreign aircraft.

Therefore, if sovereignty exists indefinitely upward into space, then by virtue of such sovereignty, each state has a complete veto as to the use of that space.

As high as your territory goes, to that height, in the absence of agreement, you have complete right of control. As Chief Justice Marshall said—

> All exceptions to the full and complete power of a nation within its own territory must be traced to the consent of the nation itself.

I would concur with Mr. Becker in that what he has said may be the practical answer. But so far as my own judgment as a lawyer is concerned, if territorial space extends indefinitely upward, then a technical right of veto exists in any state flown over to deny even civil and peaceful uses of that space.

May I give you an example, sir?

The United States in negotiating rights of foreign aircraft to enter the United States permits one foreign airline to enter, denies another; it is not obligated to say why; for the reason that it goes back to what Vattel first carefully set out in the middle of the 18th century, namely, that sovereignty carries with it the complete right to control transport. And satellites, and missiles, are just another form of transport.

They are movement.

And if that movement is a foreign movement, you have no obligation of any kind to allow that foreign movement to enter your territory.

Therefore, I repeat what I said a little while ago: If I were a member of this space agency when it is set up, the problem that you have just stated, and which has been discussed before, would be the very first thing that I would be concerned with:

Is there any direct or indirect agreement as to our right to use space above the airspace.

Mr. FELDMAN. Would you include in the proposal before this committee a provision which would enable the space agency to undertake such a consideration and study?

Mr. COOPER. I would say, sir, that I would think that would be unfortunate. I think its powers should be very general; certainly you do not want to impinge on the long-established powers of other agencies of the Government, the State Department, the Civil Aeronautics Board, all of which deal with questions of policy as to transport. What I tried to make clear, Mr. Feldman, was that I hoped the agency would not be precluded from investigating these problems, which then might be included in recommendations to the operating agencies who would be primarily responsible for international negotiations, or something of that kind.

Mr. SISK. Mr. Becker wanted to comment on that.

Mr. BECKER. I was saying that this is an area in which we have got to do a great deal of work and study.

For example, the statement was made about the right implied from sovereignty of absolute control over transport. Is a satellite a transport?

Mr. SISK. Well, could I ask another question right there? This is something that seemingly could immediately confront us.

Maybe you do not want to comment on this. If you do not, you are perfectly free to state that you do not.

Assuming that tomorrow a Russian satellite, came down, and they were able to bring it down in exactly the area they wanted and could bring it down whole. Suppose it landed within the continental United States and it had significant military information or was of significance from a military aspect. What are you prepared to do about it from the standpoint of the State Department and our Government, now? What would we do?

Mr BECKER. That would be determined by the policy people in the State Department. I am just their lawyer.

Mr. SISK. I appreciate that. But aren't we very shortly, if we progress, going to be faced with that? And what we are going to say?

According to Professor Cooper's statement about airlines, we control whether or not Russia can send in an airline, or Sweden, or Norway, or whatever country. If a Russian satellite lands in this country, what will we do about it?

Mr. BECKER. Congressman, I think you have missed one aspect of the discussion that I raised earlier.

Mr. SISK. I am sorry if I did.

Mr. BECKER. I have already pointed out that this Government has taken affirmative action to get some agreement with respect to what shall be done about satellites. And it is not the fault of this Government that we are not moving forward and talking about the type of questions you have in mind.

I don't think it would be profitable for this Government, with its present knowledge of the facts with respect of outer space, to try unilaterally to develop a code of law with respect to outer space. Because that type of thing, when you get down to the last analysis in international law, international law is what sovereign states agree upon.

So we are taking initiative in the area.

Thus far we haven't had any indication that others were prepared to sit down and talk with us on that subject.

Mr. SISK. I can understand that. I agree with you, Mr. Becker. It is not something we can do unilaterally. The thing I was concerned with was just how far we have progressed. Apparently we have not progressed at all.

Mr. BECKER. I think the basic reason we haven't tried to get multilateral agreement on the types of questions that we have here is that there is a lot more study that we can make into the facts here before we are prepared to give an answer. Because, remember at all times that there are two aspects of this.

The one is this, what action is or could be taken by other states, and at the same time we have to think of what action is or can be taken by the United States.

Mr. SISK. Certainly. We can turn the situation around and assume that one of our satellites landed in Russia; then what would our position be?

Mr. BECKER. That is correct.

Mr. SISK. Mr. McDonough.

Mr. McDONOUGH. Mr. Becker and Professor Cooper, I appreciate your statements. You have enlightened us a great deal on a very difficult problem.

Insofar as the present satellites in orbit are concerned, the United States and Russia are the only two nations that have been capable of releasing them. Both countries released them during the Geophysical Year, which I understand was mutually agreed upon between those nations participating, that there would be no objection to the release of satellites into outer space during that year.

Mr. BECKER. There was no intergovernmental agreement.

Mr. McDONOUGH. Not intergovernmental; no.

Mr. BECKER. There was agreement among the scientists concerned with it. The governments did make affirmative statements they

planned to do this. And there was no protest by any government with respect to that announcement.

Mr. McDONOUGH. So that the mutual understanding that we have now, if only on a scientific basis, is only for the Geophysical Year.

The problem in my mind is that when the Geophysical Year terminates, if Russia should then declare that any satellite passing over her territory would be an overt act, are we prepared—is the United States Government prepared—to combat that situation?

Mr. BECKER. Well, our present announced position is that we want to talk about the general problem. And that includes the devotion to peaceful purposes. That is where we start from. That discussion will involve questions of what can be done. And we haven't given up hope that we may make some progress in that regard.

Therefore, we are not going to take a position as to what we will do if the year ends before we have started those talks, until it is necessary to do so.

Mr. McDONOUGH. Now in determining a territorial area over a nation into outer space, wouldn't we first of all have to chart that area and determine position, such as we do on water, the longitude and latitude positions?

Do we have any such charting of that area now so we can determine position?

Mr. BECKER. I was just looking for a definition. There is an interesting definition of airspace in the United States Air Force Dictionary. Airspace is:

> Space in the air or space above a particular surface of the earth, especially such space considered to have a particular shape and extent for a particular purpose.

In other words, airspace is commonly defined by the outline of the geographical area below it. And it is considered to extend upward indefinitely.

Mr. McDONOUGH. In considering that, if the earth were merely revolving, that is one thing. We are not only revolving, but we are rotating The territorial boundary lines of a state on the earth in the revolutions of the earth would be an instant area. We are traveling what?—1,100 miles by revolution, and some 66,000 miles an hour by rotation

So that these areas you are talking about in space, if they are accepted as territorial boundary lines, they would be instant areas, wouldn't they?

Mr BECKER. When you start talking on this subject with scientists, you sometimes get surprises. I was talking with a scientist on the general subject one day and talked about air space. We have the concept that the air above the United States is owned by the United States. That is not a fact. It is well known that weather is moving the air in general from west to east. So that the air we have in our air space above us today, a day or so ago may have been in Russia or may have been in Japan.

Mr. McDONOUGH. The physical air.

Mr. BECKER. I meant to say the fact that there is movement or that the airspace above you may have different molecules in it is not a new problem. And even though we have absolute sovereignty, let us say, over our airspace, if we were to extract all of the oxygen from

the air as it left our east coast, I think other nations might have something to say about it, regardless of our absolute sovereignty.

And so we have managed to work out a system of sovereignty of airspace, notwithstanding the scientific facts that scientists deal with every day.

I would suggest in our problems on outer space, even though they seem new, we need a great deal of study of what are the facts, where are you in relation to various areas when you are actually up there, before we make any decision as to what should be sovereign rights there.

Mr. McDONOUGH. To determine where you are, wouldn't you have to chart the area? Wouldn't you have to have a known specific point determined by geometric lines or bands of area around the universe, taking the sun as the center of the galaxy. We are part of a planetary system. We are one of the satellites of the sun. There must be some boundary line on which we could chart our position, and then as a nation determine if our territorial rights are limited in outerspace to that area—or geographic area on earth.

Any invasion to that area by another nation would have to be determined as to what time that invasion was; because the position is different both in revolution and in rotation.

Mr. Cooper, what is your opinion of that?

Mr. COOPER. My own view, sir, is that the air, as air, has practically nothing to do with it.

I think we are talking about space That dispute first arose historically about 1906 between two professors, one talking about sovereignty of the air, and one talking about the sovereignty of the airspace. It has been proved that it is the sovereignty of the airspace involved.

I think we are going to end up with some kind of agreement that the space X distance above the surface of any state is part of the territory of that state.

I would like to see some general attempt at a fairly early date to reach that kind of a conclusion. I may be entirely impractical. Maybe it is better to take it on a case-by-case basis and proceed as the Government of the United States has alone discussed at this time—the peaceful use of outer space—without saying who is sovereign in the areas to be used.

In other words, the present attempt, as I understand Mr. Becker, has been that there should be an agreement on outer space—and I would call your attention, sir, to the fact that neither the President nor the Secretary of State in any of the communications—nor Mr. Lodge—defined what they meant by outer space.

They simply said there should be peaceful use of outer space. That was the case-by-case effort to preserve the right to use peacefully for all concerned an area without determining the sovereignty of the area.

I think sooner or later the United States has got to decide how high what I call its biggest boundary is.

In other words, are we 50 miles away from international territory above us; are we a hundred miles; or are we a thousand miles away?

It is a fact that sooner or later we have got to determine. I think, however, the crucial thing at the present time is that there should be some understanding that we may continue the peaceful use for scien-

tific purposes of areas above and beyond the airspace in the strictest idea of airspace where there is enough air to support an aircraft.

And that is a case-by-case problem.

Mr. McDONOUGH. At the present time we do have international law or at least international understanding as to what area a foreign aircraft can enter over the territorial United States. What is the maximum height of that?

Mr. BECKER. There is no maximum stated.

Mr. McDONOUGH. There is none?

Mr. BECKER. There is none; no, sir.

Let me add one word on that problem of sovereignty in space.

I do not think we should be in a hurry to delimit or restrict the sovereignty of the United States unless we know that we are on the right road.

Now, the problems that people have with respect to space vehicles and satellites does not relate to the question of sovereignty basically; it relates to the question of what is the effect of these objects upon me or we and our interests. Now, our approach is to put aside for the moment the relatively theoretical question of sovereignty, because we might make a mistake.

And then to concentrate on seeing if we can get some agreement so that these objects will not be used in a manner that is contrary to our interest.

It is only after we have a great deal more knowledge that I feel we want to make a final decision that the boundary of the United States goes this far and no farther. Because once that decision is made, it is a permanent decision.

Mr McDONOUGH. Well, isn't there some indication of the attitude of Russia, especially in the Arctic, here in this recent attempt on their part to say that we were invading their area?

Mr. BECKER. I did not see any claim of invasion.

Mr. McDONOUGH. Well, they claimed that the SAC bombers were traveling over their areas.

Mr. BECKER. They said we were approaching their border. I do not recall that they claimed we infringed their territory.

Mr. McDONOUGH. Then, what is this most recent dispute in the Arctic; the one you just cited a few minutes ago that for some 20 years we have been operating within areas that are undefinable as far as territorial rights are concerned in the Arctic.

Mr. BECKER. That was the Antarctic.

Mr. McDONOUGH. The Antarctic?

Mr. BECKER. Yes.

Mr. McDONOUGH. In other words, if we do not take a position soon, restricted or otherwise, and if Russia should take a position that all outer space is their territory—then we are challenged, and we will have to take a position; isn't that right?

Mr. BECKER. It makes no difference whatsoever, sir. We faced that problem with respect to the Antarctic. Because people have been urging us for years and years and years—they have been urging the United States to assert a claim in the Antarctic.

And we have pointed out time and time again that our rights are not dependent upon making a claim.

In international law, when you have rights, you do not have to make claims of sovereignty in order to be entitled to the benefits that

those rights confer upon you. And there may be times when it is politically unwise to make a claim.

It is much better to adjust the thing in a practical manner. That is the general approach we have adopted with respect to Antarctica.

It has not worked badly, really.

Mr. McDonough. And has that been accepted by Russia?

Mr. Becker. I have not seen whether we have an answer to the note as yet.

It only went out a few days ago. And it is a relatively major proposal.

Mr. McDonough. That is all, Mr. Chairman. Thank you.

Mr. Hays. Mr. Fulton.

Mr. Fulton. May I compliment Mr. Becker on his foresightedness in last year starting into the study of the law of outer space as the leagal adviser and counsel of the Department of State.

Mr. Becker. Thank you.

Mr. Fulton. I think he has been forward looking and has certainly been giving this matter some thought, even prior to action by Congress.

Likewise, I would like to compliment Professor Cooper on his fine work over the years. These matters that have not had public attention and seemed of no great importance are often a heavy burden to carry.

My first question is basic—I am a member of the House Foreign Affairs Committee: Is space policy foreign policy, as far as the United States Government is concerned?

Will you put that in the record later?

The second thing is this:

Under our United States Constitution we are a group of 48 States, each with a State sovereignty over its territory. And then the question comes up: Is this a Federal jurisdiction or a 48-State jurisdiction, with each State having sovereignty over its own territory?

I would rather move quickly. So you may revise your remarks when you review the record.

(Mr. Becker's response will be found on p. 1307.)

Mr. Becker. I haven't considered that domestic aspect. But my offhand answer is that Congress has settled that question by the Civil Aeronautics Act and related acts in which the Federal Government regulates air movement above the States, because it is generally interstate.

I think they even regulate intrastate movement through the CAB.

Mr. Fulton. Well, of course, Congress is given the power to make all laws which shall be necessary and proper for carrying into execution the powers of the United States and of the Constitution.

That would be in article I, section 8.

Now, would it come under that Constitutionwise; or are we just proceeding by assuming the authority?

Mr. Becker. I do not quite understand that question, Mr. Fulton.

Mr. Fulton. You say Congress has already done it as far as aeronautical rules and regulations are concerned. So, I am saying: Is it under the general powers of Congress given under article I, section 8, where we are allowed to make all the laws which shall be necessary and proper for carrying into execution the general powers?

Mr. Becker. No, I believe the various air acts are under the interstate commerce power.

Mr. Fulton. Professor Cooper?

Mr. COOPER. If your staff will find the history of the Air Commerce Act of 1926, that reflects exactly a long series of debates which occurred 5 or 6 years before that time as to whether, in order for the Federal Government to regulate flight, a Constitutional amendment would be necessary or whether it could be done under the various clauses.

There was a general agreement finally reached, which the Congress apparently acted on in the adoption of the Air Commerce Act of 1926, that flight could be a subject of Federal regulation.

I think you will find that one report of the American Bar Association Committee in the early days went so far as to raise exactly the question that you had, the question of whether or not a Constitutional amendment was not needed.

Mr. FULTON. Well, my point is this, really: Whether we have to put it under something like the commerce laws, when obviously there is no commerce in outer space or whether we put it under article I, section 8, which is the general powers given to Congress to implement the Constitution.

We have the right to make all the laws. And, likewise, we have the right to make laws and regulations that will carry out any other powers in the general powers vested by the Constitution in the Government of the United States or any department or officer.

Mr. BECKER. I would not be inclined so quickly to put aside the commerce

There is the potentiality of commerce and the potentiality of foreign commerce.

I think you would have some sound ground for acting there.

Mr. COOPER. I concur with Mr. Becker.

I think such legislation as we have before you could be justified under both clauses.

Mr. FULTON. I see.

Now, then, you would take an air vehicle with an earth-to-earth destination as surely being under the previous decision. But the query is: Suppose you had an outer space missile which just went off like Columbus in 1492?

Mr. BECKER. I think the constitutional concepts there will have to keep up with the facts.

Mr. COOPER. Plus the potential of the United States as a fundamental matter.

Mr. FULTON. I live in Pennsylvania. And we remember the 16th amendment. That says Congress may—well, take the 10th amendment—the powers that are not delegated to the United States by the Constitution or prohibited by it to the States are reserved to the States respectively.

Now, the question comes up: I am in Pittsburgh, Pa., and our local government decides we are going to shoot a rocket to celebrate our 200th bicentennial there in outer space.

And you people in the Federal Government come along and say you are not allowed to. I say "All right." I am a private citizen there, and I say I am going to. So the question comes up: Am I as a private citizen allowed to enter into outer space without an exit visa or without a permit or paying a license fee to put a rocket up.

Or could I as a municipal government, as part of the government of Pennsylvania, go ahead and do it?

Or are you going to limit that solely to the Federal Government and keep everybody else out of it?

Mr. BECKER. Well, I suppose the easy answer to that question is—well, I may say that with respect to matters of domestic law I trust you do not hear me as a witness on behalf of the State Department; it is merely an interesting discussion as far as I am concerned.

But I suppose we won't have to——

Mr. FULTON. Or, secondly, let me ask you this: Will there be free enterprise in outer space? Can I send up something that says "Fulton's Vitamins"?

Mr. BECKER. The quick answer to that right now is that it would be so expensive to put these objects up that the problem is not going to arise immediately in a practical context.

Mr. FULTON. Yes.

The theory that we put in outer space in a philosophy will probably, through the work of this committee, have a governing impact just the way these various things cited by Professor Cooper have had previously.

Mr. BECKER. I do not mean to say that there aren't all sorts of questions we are going to have to go into here.

But I think you are demonstrating that we have got a lot of studying to do.

Mr. FULTON. May I say to Professor Cooper: Let's go back into history——

Mr. COOPER. May I interrupt you?

Mr. FULTON. Yes.

Mr. COOPER. It seems to me that we might take a look at the final decision in the Tidelands case in which it was held—and I thought it was bad law, but I do not have the last word—in which it was held that Federal jurisdiction alone existed because the doctrine that the territorial sea is part of the territory of the United States did not become part of international law and the law of the United States until after the Constitution was adopted; and, therefore, the territorial sea was after-acquired Federal territory and did not become part of the adjacent States.

Perhaps we may reach a problem where any extension upward of space not now used may be held hereafter by some court as after-acquired territory so far as the United States is concerned.

Mr. FULTON. Previously, we discussed the height to which property that is owned by a citizen of the United States goes. If property lines are parallel lines on each side of the property intersecting each property line, we would then get either a square or at least some sort of a section that went out through space continuously.

But if you say that isn't the case, then you are going to have to say that the property lines are really the extension of a cord that starts on the earth's surface, and on each side of the property goes out through where the property line intersects the circumference of the earth, or about there, and then goes out into space.

Now, on the first assumption, I would say to Professor Cooper, the peculiar thing is that if I have a hundred feet of property on the earth and go up a thousand miles above the earth, and I am going to try to determine what property I have up there, the circumference of the earth at a thousand miles would have gone 2π. So its circumference instead of being 24,833 miles would be 31,416 miles.

Likewise my 100-foot square plot of property 1,000 miles out in space would have a gap of 50 feet separating it from the plot of my neighbor if his were of similar size. If our two plots were larger, the gap would be larger.

Mr. COOPER. I agree with you if you accept the concept that private property extends indefinitely upwards in space; I think that was destroyed in the United States by the Causby decision in the Supreme Court.

Mr. FULTON. Yes.

But then the question is: Who owns the property as soon as I get up an appreciable distance between me and the man who owns property next to me in the United States? Who owns it?

Mr. COOPER I think the reasoning would be that you move from the line through the center of the earth, through the edge of your property upward in space; so, your area would not be a box.

Your area is, in my judgment, defined by the two lines that move from the center of the earth through your boundaries.

The only question is as to where the top of the atmosphere is.

Mr. FULTON. So, really, we get out into outer space where we own many, many thousands of miles—hundreds of thousands of miles—of space, and we are then separated between each other by a distance, for example Russia and the United States, that we do not even know.

We cannot even tell within a third of a mile how far New York is from Moscow, for example.

Mr. COOPER. I thought the inaccuracy was even larger than that.

Mr. FULTON. There is even a disagreement between the Russians and ourselves on the inaccuracy.

Mr. COOPER. I do not believe in this case—or I do not think the problem really affects these considerations at all.

Mr. FELDMAN. Is there any analogy, getting back to your original question about your rights as a private citizen to shoot a rocket into the air or into space—is there any analogy in the licensing features in the aeronautics law which requires anybody flying to have a license before he can fly?

Secondly, isn't there also an analogy due to the fact that aircraft are constantly flying over property. And the fact that they continue to fly in that same area or continue to fly over that property might give them some adverse right.

But nobody does anything about it anyway.

Mr. COOPER. By your first question, you pinpointed one of my real problems about the present status of the law in the United States.

As I pointed out in the paper I filed with you, a rocket in my judgment is not an aircraft subject to regulation under any of our present statutes and regulations on account of the definitions involved.

Mr. FULTON. I must disagree with you.

Mr. COOPER. I am giving you my professional judgment for what it may be worth. We have not attempted to regulate anything but aircraft.

Mr. FULTON. Under article X, section 3 of the Constitution, the Congress shall have the power to dispose of and make all needful rules and regulations respecting the territory or other property belonging to the United States.

Certainly that rocket belongs to the United States.

Mr. COOPER. I say up to now there has not been, in my judgment, adequate regulation of rocket flight.

Mr. FULTON. But there is the authority in the United States to regulate it?

Mr. COOPER. The authority certainly exists. There is no question about that at all

Mr. FULTON. No matter where?

Mr. COOPER. I agree thoroughly if it is an American rocket.

Mr. FELDMAN. We do have the right to regulate?

Mr. COOPER. No question about that at all.

Mr. FULTON. If you put a person in it, we have the right under the 16th amendment; because we can tax it up there if we want to, can't we?

So that maybe Congress is moving into a field where we have the right to tax in outer space, do we not? Is that right?

Mr. COOPER. That is one that I have never thought of before.

Mr. FELDMAN. How would you collect the taxes?

Mr. COOPER. To finish answering Mr. Fulton's question. I think the adjudicated cases are now pretty clear that there is no prohibition against normal flight in areas that do not injure the use of the subjacent property; and that the mere continued flight to and fro does not at the same time give the man flying any property rights in the lands below.

Mr. FULTON. Suppose we put a Navy man in one of these space ships and send him into outer space; does it pay his income tax under the 16th amendment when he is out in outer space?

Mr. COOPER. When I was a naval officer they hadn't invented the income tax. I would not know.

Mr. FULTON. The 16th amendment specifically says that Congress shall have the power to put an income tax and collect taxes on incomes from whatever source derived.

So that means outer space too.

So, if the man is paid for working in outer space, we tax him, don't we?

Mr. BECKER. Paid by whom?

It seems to me—I am not going to discuss the tax laws, but you certainly collect income taxes regardless of whether or not a man spends the year in China or Europe.

It seems to me that——

Mr. FULTON. Well, here is a new frontier. Do we collect them in outer space?

Suppose I shoot a satellite into outer space and still own it, can I collect income depletion on it or is it lost?

Mr. BECKER. The answer to that is: If outer space is within the sovereignty of the United States, there isn't any question of it.

If it is not within the sovereignty of the United States, it depends upon your right to tax citizens when they are outside the territory of the United States.

Mr. FULTON. Now, our bill, as set up, has a civilian agency.

And we limit it. We give it full power except insofar as such activities may be peculiar to or primarily associated with weapons systems or military operations. That means we do not have one agency that looks after the whole space policy of the United States.

At this point I favor a space agency which implements a national space policy, both military and civilian, as outlined and set up by the President and, of course, under regulations and laws of Congress.

Do you go that far? Would you have just a space agency that is civilian alone, and then have another military space agency such as the Advanced Research Projects Agency—ARPA—under the Defense Department? Or would you combine the two?

Would you have an overall space policy agency?

And I have one question in conclusion:

In our philosophy of approaching outer space, should we approach it the way countries approached the 15th and 16th centuries? Should we take Grotius' approach of the freedom of the seas, or should we take John Seldon's approach for Britain in 1635 when he said that Britain must have dominion of the seas?

Or should we take Cabot Lodge's approach and put it in the United States? Or should we take the method that was proposed and acted upon in 1899 on the First Hague Conference, in 1907 on the Second Hague Conference, a conference of all the nations of the world, to try to work out a policy for outer space just as we did on the International Court of Justice?

You see, mine is the latter.

I would say don't put it in power politics through the UN, but start it with that kind of a conference called through possibly NATO, and put it at the summit in the next conference, with preparations through NATO.

Mr. COOPER. Can I answer that question purely as a private citizen and scholar?

Mr. FULTON. I would like to have you do that; yes, sir.

Mr. COOPER. I have always been impressed with the great admiralty decisions of the early part of the 19th century, which put the doctrine of freedom of the seas on the basis that the seas were a highway which should be maintained open for all states.

Grotius argued the doctrine of the freedom of the seas largely because they could not be possessed or controlled. He stated that there was no power to control the seas.

On the other hand, when the great admiralty decisions in the British and American courts came out at the end of the 18th century and the beginning of the 19th century, it was laid down that the doctrine of the freedom of the seas was primarily a problem of maintaining for the use of the peoples of the world a common highway which should not be impeded or seized.

I feel exactly the same thing, if I may say so, as to outer space. I think its future is part of a great highway for the peaceful use by the peoples of the world.

Mr. FULTON. But you do not think that if we adopt the power-to-control theory that we are then in a race in outer space—higher and faster with military weapons—and we will finally end up as England and Spain did, with the Spanish Armada; that we finally will come to the point where we have got to have a showdown on it for the power to control?

Should we go on that basis?

Mr. COOPER. I thoroughly dislike the theory that sovereignty is based on power. I asked a distinguished lawyer once who had

served on the World Court whether sovereignty was the right to control or the power to control.

I never did get a very concrete answer, but to me sovereignty is the right of a state to control a particular area within boundaries which the international community has admitted exists.

Now, I think that was approximately the basis on which Dr. Huber decided in the island of Palmas arbitration as to what constituted territorial sovereignty.

Mr. FULTON. That is my last question.

May I ask you if you would put a summary of your War College lecture in 1948 in the record?

Mr. COOPER. It is no longer classified. Yes, I would put that in.

Mr. FULTON. Like your materials on missiles and satellites policy of 1958 and the legal problems of upper space?

Mr. COOPER. I have given copies to Mr. Feldman.

Mr. FULTON. Likewise from Mr. Becker a summary of your testimony before the Foreign Affairs Committee on this same subject, if you would.

And then I would like in the record, too, the Paris Convention, the Chicago Convention, either summaries or outlines of them, as well as the annexes, so we can have them for reference material, as well as any documents these gentlemen have referred to of a legal nature.

Mr. COOPER. The United States published in the early part of 1940 or thereabouts an official copy of the Paris Convention with the annexes in all three languages. So far as the annexes to the Chicago Convention are concerned, they are very voluminous. I regret that personally I am not in position to supply the desired material.

Mr. FULTON. I said summaries.

Mr. HAYS. If the gentleman will amend his request to provide that the summaries are to be checked with Mr Feldman?

Mr. FULTON. That is right.

Mr. HAYS. So there will be some screening.

Mr. FULTON. That is right.

And any pertinent provisions you referred to, that we put those in the exact words particularly.

Mr. HAYS. Without objection, they will be made part of the record.

(Material referred to begins on p. 1310.)

Mr. HAYS. Mr. Keating.

Mr. KEATING. Messrs. Becker and Cooper, this question is addressed to both of you.

I gain the impression despite your statement that you were in substantial agreement—I gained the impression that you, Mr. Becker, would prefer to await the gathering of more significant and reliable physical data on outer space before we begin to make new law and suggest a case-by-case approach.

On the other hand, my impression of Professor Cooper's position is that he considers the political implications of the situation imminent and grave enough to act now or in the immediate future before dangerous disputes arise.

Would that be a fair analysis of the divergence in your thinking on this point?

Mr. BECKER. I do not know exactly what we should do now, because the implication I do not entirely agree with is that we are not acting now.

We, through the President, through the Secretary of State, and through Ambassador Lodge, have taken some significant action now. It began as early as January of 1957, I believe, in the United Nations.

And we have called upon the other power that has a capability in this area to agree with us that it will be limited to peaceful uses.

And, as I have said before, when you discuss this basic question, you are bound to discuss what those uses are and what is permissible and what is not. So that we are acting now.

But the thing that I do not want to do and that I think the Department does not want to do is to sit down and write an *a priori* code of laws with respect to space when no man has ever been there. And I do not think that we have enough knowledge to say exactly what the conditions will be that we want to legislate about.

But I do not want the impression taken that we are simply saying that nothing should be done now.

Mr. KEATING. Well, could I ask, Professor Cooper, what do you have in mind that could be done now which is over and beyond what is being done?

Mr. COOPER. Mr. Keating, I feel and have felt very strongly that if negotiations could go forward such as those which Mr. Becker has referred to, that when you reach new international agreement as to the peaceful use of outer space, you will have reached a practical answer to the question of the height of territorial space, because I think they are part and parcel of the same thing.

My major concern is this: I hope the decision as to the territorial upper space boundary of the United States will not be too long delayed. I fully agree that if negotiations which were taken up could be actively handled, that within those negotiations there would necessarily follow a determination as to what extent a state could or could not impede future civil flight—provided at the same time that there were a determination that whether it was territorial space or not, military flight above another state could not be undertaken.

I think on the basis of that very simple formula that the President proposed and that Mr. Lodge followed in the United Nations and which was discussed in the Disarmament Commission in London—I think on that very simple formula of the peaceful use of outer space, you open the gate to solving the major problems.

My concern is that there is no solution now.

Mr. FELDMAN. Could you summarize what has just been said this way:

That one of the aims of the President's proposal and the legislation before us is the exploration of space, and your suggestion is that concomitant with that, we must also explore the law of space?

Mr COOPER. Yes, sir.

So that we may be sure that this commission or this board or what ever it is, this agency, in seeking to explore outer space for peaceful purposes does not collide with unsettled problems which may cause serious international dispute.

That is my major concern.

Mr. KEATING. Do you think there would be merit, despite the strong statements which the President has made declaring that outer space should be used only for peaceful purposes—would there not be merit also in a congressional resolution stating that to be the sense of the Congress as expressing the will of the American people?

Mr. COOPER. Mr. Keating, I am not sufficiently knowledgeable of the difference between the statute and the resolution, or to what extent they are needed to assist or aid any executive pronouncement, to say.

I think that should come—I can only say, my personal view has always been that anything that can be done to assure peaceful use of outer space should be done.

As to the mechanics, I do not presume myself qualified to say.

Mr. KEATING. Probably, Mr. Becker, you might not want to express a view with regard to that?

Mr. BECKER. I would prefer not to at this time, Mr. Keating.

Mr. KEATING. I note on page 6 of your statement, Professor Cooper, that you say "Preferably that a new convention be adopted fixing the boundaries" and so on.

In other words, that is the course you think is the preferable one.

Do you think immediate steps should be taken to bring that about by international agreement?

Mr. COOPER. I feel about that exactly as I do about the position with reference to what has been termed a summit conference; that there should be adequate preparation before any such convention was ever called.

And I would call your attention to the fact—I do not know whether Mr. Becker knows it—that the State Department in 1943 and 1944 explored at great length with the major flying nations of the world problems that might arise at the Chicago Conference before they ever called the Conference.

In other words, sir, I feel the very objective that I have indicated as desirable might be destroyed by too precipitant calling of a diplomatic conference to consider undigested proposals.

I went through a similar experience in 1947 with a conference also at Geneva where we sought to clarify certain of the unwritten parts of the Chicago Convention as to commercial flights. And there it broke down because there had not been some general understanding in advance of what certain nations—what positions certain nations might take.

Mr. KEATING. Professor Cooper, you have gone over this bill, I think you said.

Mr. COOPER. I have, sir.

Mr. KEATING. Do you think that on the second page of it that the way it is drawn there is an overemphasis or too great emphasis placed on military control as has been indicated recently by some high authorities?

Mr. COOPER. That I have not studied.

I was studying particularly where the agency might have to deal with the problems with which I was concerned, namely, research into problems involved in peaceful flight.

The problem you have just raised I have never focused upon.

Mr. KEATING. Well, I was rather amazed to see a statement by a distinguished Member of the other body to the effect that this legislation as proposed placed too much authority in the military. I would think perhaps just the opposite was the fact and that we should give the military more of a voice in the consideration of policy questions than is incorporated in this legislation.

I am referring particularly to that sentence which says Congress declares that the activities shall be directed by a civilian agency except such as may be peculiar to or primarily associated with weapons systems, in which case the agency may act in cooperation with and on behalf of the Department of Defense.

Now, certainly the Department of Defense is the one which at present has done the extensive work in this field. And I would be happy to have your comment on that provision.

Mr. COOPER As I read this, as a lawyer, and only as a lawyer, and I have not studied it very materially, I took it that the court might well say that the activities referred to are the use of space and that normally the civilian agency should have general control of such activities except as they were military; and I would assume that in order to come within the exception, there would have to be a showing they were peculiarily or primarily associated with the use of governments

Mr. KEATING. That is my interpretation.

Mr. COOPER. That is the way I would construe that, that where a general power is granted subject to an exception, the person seeking to rely on the exception must indicate that he is entitled to the exception.

Mr. KEATING. That is right.

And the Defense Department, through several witnesses, has made very strong representation to us that this places too great a burden upon them and that they need to have a rewording in order to give them a greater voice in space exploration.

Mr. COOPER I know nothing about what decisions may have been made by the people who drafted the bill or by the President in recommending this But you have asked my view as a lawyer.

And, as a lawyer, my judgment would be that the primary responsibility is put upon the civilian agency, but there is reserved out of that those things which are essentially military And that, if I may say so, is not very different from the present situation as to flight in the airspace, as between the Civil Aeronautics Board and the Armed Forces

Mr. KEATING. Departing from your position as a lawyer for a moment to that of a citizen, isn't it your impression that that is the way it should be set up?

Mr. COOPER I think, sir, that this would be workable.

Mr. KEATING. Would you care to comment on that, Mr. Becker? Have you gone over that wording? What do you think of that wording?

Mr BECKER. I would really prefer not to comment, because I am appearing here as a Department witness.

Mr. KEATING All right.

I think any assertion that this bill, as drawn, places too great authority in the military is completely without foundation

Mr. FELDMAN. Would you yield for just a short point?

Mr KEATING. Yes, sir.

Mr. FELDMAN. I think when Dr Dryden was here he felt there might be some ambiguity in this particular point. The exception says:

> Except insofar as such activities may be peculiar to or primarily associated with weapons systems of military operations in which case the agency may act in cooperation with or on behalf of the Department of Defense.

Dr. Dryden felt the words "on behalf of" may have conveyed a wrong connotation.

Mr. COOPER. I would certainly agree that that might be clarified. I can understand cooperation, but I don't understand what is meant by "on behalf of."

Mr. KEATING. With these satellites orbiting around the earth and with the talk that we hear about rockets to the moon, and other kinds of vehicles in space, you would both agree, would you not, that we need additional laws to govern the problems not only of the rights and liabilities as between the nations, but as between nations and individuals?

In other words, that we must have some new laws to meet these new concepts?

Mr. BECKER. Insofar as these objects come into the airspace and have some effect upon individuals, I think we have an existing body of both domestic and international law that we could apply without having any specific new law.

That is to say, I do not think it is very different if a satellite falls on my house from an airplane falling on my house.

Probably the liability would be more absolute in the case of a satellite, because it is more analogous to shooting a bullet which may fall on anybody; in that area I think we have a body of law that, again, until we learn a little more of specific problems we will have to face, would be adequate for the present time.

If you are speaking of relationships between governments and individuals when the individuals are located in outer space, I suppose other than the laws of nationality, allegiance, and so on, and so forth, we might have to think out some additional law.

Mr. KEATING. But you think our domestic laws today are broad enough to cover problems that would come about through misguided missiles or collisions in outer space, if that is possible of conception, or the rights of a launching nation to a downed satellite which comes down in another country.

Mr. BECKER I have not studied the domestic law with that in mind.

I am not certain whether there should be a clarification of the civil aviation laws to insure that they would govern the flight of missiles and things of that sort. I have given some thought to the international aspects of it

And, as I see it, we have well-recognized international law governing airspace. And there is no question in my mind but that an infringement of the airspace by a satellite or missile would be identical with the infringement of the airspace by an airplane.

And under certain international law, we have very well-defined rights in that regard. We have the right to say "Stay out. We do not want you in there."

And we have the sovereign right to insist upon that. If others do not recognize that, then we have the sovereign right to confiscate or take such action as we deem necessary to protect ourselves.

Mr. COOPER. The entire problem, sir, in my judgment, goes back to my two basic concerns: That we must know the legal status of the area in which the movement takes place.

If it is airspace, if it is part of the territorial space of the United States, then the law of the United States will apply, whether it be

private wrongs or otherwise. If the area of the occurrence which gives rise to the right occurs outside of the territorial jurisdiction of the United States, then you have an entirely different problem.

And basically, as a man who has tried to study these questions for a long time, I feel it is highly important that we should not too long delay determining where the law of the United States, as law, is effective.

It is effective within its territory. I want to be sure where we find the territory of the United States.

The next thing is that you must determine the legal status of the instrumentality. That is a point I suggested in my paper. And you have real difficulties. While I agree with Mr. Becker, we can forbid on a general basis of international law the entrance of rockets and other things into our territory, nevertheless, the regulation of flights of rockets in our territorial space does not now exist.

We have a right to regulate them, but we have not done so.

Mr. BECKER. May I add a word, Mr. Keating?

Mr. KEATING. Certainly.

Mr. BECKER. The reason I answered the way I did is that as I understood your question it was a further law with respect to the relationship of the government and citizens and their rights and things of that sort.

And that is why I deliberately confined myself to the airspace; because when you get beyond that, you just don't have any citizens outside there. And my feeling would be: let's wait until they get out there, until we see what the legislation will do as to their activities out there.

Mr. KEATING. I have another committee meeting at 2 o'clock. But I do want to express to you, Professor Cooper, my personal gratitude for the assistance you have given me in some of my space activities.

Mr. HAYS. Mr. Ford.

Mr. FORD. As Professor Cooper indicated in his prepared statement, the Soviet Government has for many years asserted its airspace sovereignty.

From a practical point of view, we know what they have done when any aircraft have actually or allegedly violated their territory. In addition, isn't it true that before they landed any of their aircraft in the United States, they sought permission from the United States?

Mr. BECKER. That is correct. They would have to do so.

Mr. FORD. It is my recollection that within the last 3 or 4 months they landed one of their aircraft here, and prior to that had sought actual permission for such a landing.

Mr. BECKER. They have no scheduled routes coming into the United States. So, each flight, a separate arrangement is made.

In the exchange agreement that we recently concluded with the Soviet Union, there is a separate provision for the parties discussing the possibility of a scheduled route between Moscow and Washington. They would be obligated to do that.

Mr. FORD. In other words, whether they have approved officially at the Chicago Convention as a practical matter, they have abided by the intent of the Convention?

If we expanded the intent of the Chicago Convention to go beyond the intent at that time, then that is a precedent for us to control outer

space and is likewise a precedent for them to control outer space; is that correct?

Mr. BECKER. That is correct.

You say if we said that our sovereignty extended into space, that would be a unilateral determination and ultimately if enough nations said that it would become customary international law?

Mr. FORD. Yes.

And the Soviet, by practice, have set a precedent, if we followed the agreements under the Chicago Convention to go beyond the airspace that was used as the formula in those days?

Mr. BECKER. I do not quite understand that question, Mr. Ford.

Mr. FORD. Well, they in practice have agreed to the intent of the Chicago convention?

Mr. BECKER. That is correct.

Mr FORD. If the rest of the nations of the world used that formula hereafter, going beyond what airspace was meant to be in those days, haven't the Soviets found themselves in a precedent position that would more or less force them to carry it out in the future in the same way?

Mr. BECKER. They could take that position.

They could, of course, take the contrary position on the theory that it would be more in their advantage to deny that despite the fact that other nations had unilaterally determined otherwise.

Mr. FORD. If we take the position of the Chicago convention and extend it, and if there is an obvious military satellite circling the globe violating our territory, we have the right to destroy that weapon within our territory. Do we have the authority to destroy it just because it crossed our territory but might have gone outside our territory?

Mr. BECKER. Well, I think the specific right under article 51 of the United Nations Charter is to protect yourself—the right of individual and collective self-defense against armed attack.

It would be a question of military judgment as to whether or not that constituted that type of an infringement.

Now, something short of armed attack could endanger your security to an extent that you felt you were entitled to take affirmative action with respect to it. The situation has come up in numerous cases—I think we have 2 or 3 now pending before the International Court of Justice—of where an airplane overflying some of the Soviet bloc airspace through an error in navigation or for some other reason. When that occurs, we recognize that it was not by right of our part; and in a number of instances, where they have gotten the plane to go down, we have apologized, and the pilot has been sent back, and sometimes the plane sent back.

But we do not recognize, where it is an inadvertent invasion of airspace, the right offhand to shoot them down.

You get some difficult questions there. When you get into that area, you cannot give a categorical answer. Because, after all, it is a military judgment as to what is endangering you or what is not. And when you get a very fast plane, you sometimes cannot tell whether it is there with evil or good intent.

Mr. FORD. In other words, we have not taken the position that we must design our antisatellite equipment so that it will, of necessity,

destroy a military satellite, while it is in what we allege to be our own territory, the airspace that we contend is ours?

Mr. BECKER. We haven't taken any position on that specific point.

I think one of the things that one would have to consider in relation to any position you took would be:

Is it manned or unmanned?

Because there may be a difference between offhand shooting down a manned and controlled vehicle that can get down or that you can force down, as distinguished from one that is remote-controlled, or is merely mechanical, or electronic.

In the latter case you would have much less hesitation on taking affirmative action with respect to it.

Mr. FORD. They do not tell us whether it is manned or not.

Do we assume, then, that we have the right, regardless?

Mr. BECKER. That would be a military judgment of: Does this constitute a threat to the security of the United States? And what action should be taken in order to eliminate that threat to our security?

And I may say that we would not limit ourselves to the territorial space of the United States in making that determination.

We do the same thing out over the open sea.

Mr. FORD. That is the next point I was going to ask:

We would take the same position as far as any Soviet submarine which we knew had a military offensive capability?

Mr. BECKER. Precisely.

Mr. FORD. That is all, Mr. Chairman.

Thank you.

Mr. HAYS. I feel that this has been an imposition on you, but it is a great compliment that we have had this long session.

Will you accept the apologies of the committee? It was our eagerness to hear you and get all the information that we could.

Mr. Feldman has some questions to propound which you can answer later at your leisure.

Mr. FELDMAN. I think Congressman Keating also has some additional questions that he will submit for the record. I am sure that he would appreciate and the committee would appreciate the answers to those questions as best you can give them.

I will submit them to be copied into the record at this point.

(The questions are as follows:)

1. Can national sovereignty in outer space be unlimited?

(*a*) In view of the earth's rotation and revolution around the sun and the movement of the solar system, would it be possible in practice to determine national sovereignty in outer space by the maxim, "Cuius est solum, eius est usque ad coelum"—that is, could zones of sovereignty be established that would not overlap?

(*b*) If (*a*) is answered "yes," how would you determine jurisdiction over celestial bodies passing from time to time through different zones of sovereignty?

2. If the first question is answered "no," what criteria should determine the limits of national sovereignty in superjacent space?

3 Applying the criteria developed in the second question, how high, in your opinion, should national sovereignty extend?

4 In your opinion, what should the legal consequences be, if a space vehicle belonging to one nation entered the zone of sovereignty of another nation? For example, would the second nation be free to shoot down or to confiscate the space vehicle?

5. Assuming that the first question is answered "no," how many legally distinguishable zones of space would be necessary (e. g., a zone of national sovereignty, an intermediate zone in which there would be a right of innocent passage, and a third zone in which all passage would be unrestricted)?

6. By what means would you establish a rule of national sovereignty for outer space—by unilateral United States declaration, by treaties or executive agreements, through the U. N.?

7. Is there a need now for a rule concerning territorial claims on other celestial bodies, such as the moon? If so, what rule do you suggest?

8. What rule would you apply to the rights of private property owners in superjacent space?

9. In your opinion, should there be liability without fault for damage caused by manmade objects falling from space?

10. The only criteria mentioned in your statement for determining the upper limits of airspace are—

(a) The upper limit of aerodynamic lift (50 miles);

(b) The lower limit of aerodynamic drag (70 miles) (see statement on p. 6).

Wouldn't national defense criteria be controlling (as they presumably were, historically, in suggesting the 3-mile limit in the law of the sea)?

11. Why do you assume (p. 7 of prepared statement) that freedom of outer space would be inconsistent with national sovereignty over the moon (or other celestial bodies)?

12. As to the inherent right of self-defense set forth in article 51 of the U. N. Charter, would you consider the passage of a foreign reconnaissance satellite over United States territory (say, at a height of 500 miles) an armed attack on the United States?

13. As to the argument that the definitions of "airspace" in United States domestic law ("* * * navigation in * * * the air * * *") would apply to missiles and satellites, would you say that a missile or a satellite was "navigating" when in free fall (or only during its upward passage through the air)? Is it really material whether an object is navigating or not?

14. Will it be necessary or advisable, in your opinion, to put the Space Agency on a broader basis than the national security (i. e., the war powers of Congress), in view of the purely peaceful functions, in addition to its military functions, which the agency is expected to perform? What other basis can you suggest? ("General welfare"—for what it is worth—is now included? Commerce? Foreign relations?).

15. The rule of sovereignty completely up into space raises the question of how such a rule could be enforced. From the practical standpoint, would it be possible to determine what area belongs to each country when 2,000 miles above the earth? Will not such a rule call for a showdown between the nations involved in space exploration unless there is an agreement?

Under such a rule could the United States in good conscience proceed with space experiments after IGY ends. Even if all space above a certain height is considered free and belonging to all nations, isn't the nation which is prepared to dominate this area in a position to dominate the world just as there have been countries who were strong because they could dominate the sea and/or the air?

Mr. Hays. The committee is adjourned until 2:30 o'clock this afternoon.

(The following material was submitted to the committee:)

ANSWERS OF MR. BECKER TO QUESTIONS PROPOUNDED BY THE COMMITTEE AND ITS STAFF

Questions by Mr. Fulton:

At page 2597 of the transcript, Mr. Fulton inquired:

"Is space policy foreign policy, as far as the United States Government is concerned?"

Answer. "What the United States Government should do with respect to the entirely new field of outer space—with its as yet unexplored potentiality—poses highly important questions of national policy and of defense policy. It also inevitably poses highly important questions of foreign policy.

"Putting aside for the moment technical questions of international law—such as how high does sovereignty extend—all nations, regardless of their present capabilities, have an interest in man's activities in space, and our space planning and policy formulation must take account of that fact."

At page 2597 of the transcript, Mr. Fulton also asked:

"Is this a Federal jurisdiction or a 48-State jurisdiction, with each State having sovereignty over its own territory?"

Answer "As respects outer space, I am not aware of any determination by either Federal or State authorities on this point. If the Congress, with adequate constitutional authority, preempts the field, it will become a Federal jurisdiction."

At page 2612 of the transcript, Mr. Fulton requested that Mr. Becker furnish for the record a summary of his testimony before the Foreign Affairs Committee, and, in addition, the Paris Convention of 1919 and the Chicago Convention of 1944, including summaries of the annexes thereto

Mr. Becker's testimony on the subject of outer space before the Foreign Affairs Committee on February 11, 1958, was given in executive session, so that he is not in a position to furnish the same.

There is attached to this supplementary statement a statement of Hon. Omar Burleson, chairman of the Subcommittee on National Security and Scientific Developments Affecting Foreign Policy, of the Committee on Foreign Affairs, which was issued on February 11, 1958, following Mr Becker's testimony. There are also attached to this supplementary statement the requested copies and summaries of the Paris Convention of 1919 and the Chicago Convention of 1944.

Questions by Mr. Feldman, director of the committee staff:

At page 2631 of the transcript, Mr. Feldman posed the following question, consisting of two parts, as follows:

"1 Can national sovereignty in outer space be unlimited?

"(*a*) In view of the earth's rotation and revolution around the sun and the movement of the solar system, would it be possible in practice to determine national sovereignty in outer space by the maxim 'Cuius est solum, eius est usque ad coelum'—that is, could zones of sovereignty be established that would not overlap?

"(*b*) If (*a*) is answered 'yes,' how would you determine jurisdiction over celestial bodies passing from time to time through different zones of sovereignty?"

Answer to (*a*) "In view of the earth's rotation and revolution around the sun and the movement of the solar system, a point in space does not maintain the same position with respect to subjacent territory on earth, so that determination of sovereignty by drawing a line straight up from a particular territory or border would mean as respects any particular point in space that a nation's claim to "sovereignty" would be temporary Nevertheless, it is not inconceivable that a state might assert the right to insist that objects or vehicles emanating from another state did not have a legal right to be in a point of space directly over its territory, during the period that point is over its territory, without its permission. Similarly, a state might claim temporary 'sovereignty' over celestial bodies passing through different zones with the rotation of the earth. This is not to say that the application of such a rule is either likely or desirable. However, if this were to be the law, it would mean that unless the nations of the earth reached some cooperative agreement with respect to the use of space or the celestial bodies, each of them would have a veto power upon such use by the others."

Answer to (*b*). "More study of the facts is required before offering a definitive answer to this question "

Question. Also at page 2631 of the transcript, Mr. Feldman inquired:

"2. If the first question is answered 'no,' what criteria should determine the limits of national sovereignty in superjacent space?"

Answer. "It was the import of my testimony that we require much additional study before we shall be prepared to determine what criteria should determine the limits of national sovereignty in superjacent space. My answer to this question is to the same effect."

Question. Also at page 2631, Mr. Feldman inquired:

"3. Applying the criteria developed in the second question, how high, in your opinion, should national sovereignty extend?"

Answer "My answer to the foregoing question constitutes my answer to this one As further indicated by my testimony, I am of the view that before we attempt to develop criteria as to national sovereignty in space, we should, in line with the proposals made by the President, the Secretary of State and our Ambassador to the United Nations, seek to reach agreement that space will be devoted to peaceful purposes "

Question. At page 2631 of the transcript, Mr Feldman also inquired:

"4. In your opinion, what should the legal consequences be, if a space vehicle belonging to one nation entered the zone of sovereignty of another nation? For example, would the second nation be free to shoot down or to confiscate the space vehicle?

Answer. "My answer to this question is to be found on pages 2550–2552, inclusive, of the transcript, at pages 2585–2587 there is a colloquy between Mr. Sisk and me, which also deals with this point."

Question. At pages 2631–2632 of the transcript, Mr. Feldman inquired:

"5 Assuming that the first question is answered 'no,' how many legally distinguishable zones of space would be necessary (e g., a zone of national sovereignty, an intermediate zone in which there would be a right of innocent passage, and a third zone in which all passage would be unrestricted)?"

Answer. "As indicated by my testimony in chief, I believe that we are not sufficiently informed as to the facts of space to be able to lay down detailed rules of the type suggested by this question."

Question At page 2632, Mr. Feldman inquired·

"6 By what means would you establish a rule of national sovereignty for outer space—by unilateral United States declaration, by treaties or executive agreements, through the United States?"

Answer. "In my view, the choice of means of establishing a rule of national sovereignty for outer space should be contingent upon the determination of the desired rule. Accordingly, the only comment I would make with respect to this question at this time is that the United Nations, as such, does not possess legislative authority in the field of international law, although it could serve as a forum for reaching an international agreement on the subject."

Question. At page 2632 of the transcript, Mr. Feldman inquired:

"7. Is there a need now for a rule concerning territorial claims on other celestial bodies, such as the moon? If so, what rule do you suggest?"

Answer. Since I do not believe that we have sufficient facts in order to determine what such a rule should be, I have nothing to suggest The primary need at this time is for agreement that the activities of man on the other celestial bodies shall be peaceful. If we could reach agreement on this point, the question of territorial claims could be deferred, as the United States has done in the case of the Antarctica "

Question. At page 2632 of the transcript, Mr. Feldman also asked:

"8. What rule would you apply to the rights of private property owners in superjacent space?"

Answer. "I have no rule to suggest at this time."

Question. At page 2632 of the transcript, Mr. Feldman asked:

"9. In your opinion, should there be liability without fault for damage caused by manmade objects falling from space?"

Answer. "My views are expressed at pages 2550–2552, inclusive, of the transcript, supplemented by the colloquy with Mr. Sisk at pages 2585–2587, inclusive. I have no comment on the private law aspects of this question."

Question. At page 2632 of the transcript, Mr. Feldman posed the following question:

"10. The only criteria mentioned in your statement for determining the upper limits of 'airspace' are:

"(*a*) the upper limit of aerodynamic lift (50 miles)

"(*b*) the lower limit of aerodynamic drag (70 miles) (see statement on p 6).

"Wouldn't national defense criteria be controlling (as they presumably were, historically, in suggesting the 3-mile limit in the law of the sea)?"

Answer. "I did not mention in my statement any criteria for determining the upper limits of 'airspace,' other than the possibility that airspace could be equated to the area around the earth in which atmosphere exists."

Question. At pages 2632–2633, Mr. Feldman asked

"11. Why do you assume (p 7 of prepared statement) that freedom of outer space would be inconsistent with national sovereignty over the moon (or other celestial bodies)?"

Answer. "The assumption referred to was not made by me "

Question At page 2633 of the transcript, Mr Feldman inquired

"12 As to the inherent right of self-defense set forth in article 51 of the U. N. Charter, would you consider the passage of a foreign reconnaissance satellite over United States territory (say, at a height of 500 miles) an 'armed attack' on the United States?"

Answer. "This is the type of question which, in my view, should not be answered hypothetically, but rather in the light of all the facts as they exist at the time. Moreover, such a determination is one of policy as well as one of law."

Question. At page 2633 of the transcript, Mr. Feldman asked:

"13. As to the argument that the definitions of 'airspace' in United States domestic law ('* * * navigation in * * * the air * * *') would apply to missiles

and satellites, would you say that a missile or a satellite was 'navigating' when in free fall (or only during its upward passage through the air)? Is it really material whether an object is navigating or not?"

Answer. "In view of the phraseology of the applicable United States statute, it is material whether an object is navigating or flying. In my view, navigating could be interpreted to include a missile or a satellite in free fall."

Question. At page 2633 of the transcript, Mr. Feldman asked:

"14. Will it be necessary or advisable, in your opinion, to put the Space Agency on a broader basis than the national security (i. e., the war powers of Congress), in view of the purely peaceful functions, in addition to its military functions, which the Agency is expected to perform? What other basis can you suggest? ('General welfare'—for what it is worth—is now included? Commerce? Foreign relations?)"

Answer. "I express no view on this question of internal rather than international law."

Question. At pages 2633–2634 of the transcript, Mr. Feldman asked:

"15. The rule of sovereignty completely up into space raises the question of how such a rule could be enforced. From the practical standpoint, would it be possible to determine what area belongs to each country when 2,000 miles above the earth? Will not such a rule call for a showdown between the nations involved in space exploration unless there is an agreement?

"Under such a rule could the United States in good conscience proceed with space experiments after IGY ends. Even if all space above a certain height is considered free and belonging to all nations, isn't the nation who is prepared to dominate this area in a position to dominate the world just as there have been countries who were strong because they could dominate the sea and/or the air?"

Answer. "As pointed out in my testimony in chief, I believe that the best practical approach is that advocated by the President, the Secretary of State, and our Ambassador to the United Nations, namely, that other interested nations agree with the United States that outer space will be devoted exclusively to peaceful purposes If such agreement can be reached, and in the course of such agreement there will have to be a definition of what are peaceful uses, the questions here suggested will not arise."

Answers of John C. Cooper to Questions Submitted by Mr. Feldman

(1) In answering the first question as to possible unlimited national outer space sovereignty and the other questions, I wish to suggest that these questions are proof of the need for a Space Agency authorized to conduct "continuing and long-range research" in the wide field of "problems of flight within and outside the earth's atmosphere " Any answers now given to these searching questions must be tentative. They should be studied by a group representing military, scientific, diplomatic, and legal points of view Broad policy recommendations would then be available to the Government to meet the greatest challenge of the present day—the peaceful use of outer space as a new highway for communication between the peoples of the world

Answering the specific question No. 1, the answer is "No," in the absence of wide and specific international agreement. In my Mexico City talk in 1951, (being put in the record at the request of Mr Fulton), I pointed out some of the reasons why unlimited sovereignty upward cannot be claimed. Sovereignty ordinarily must be coupled with reasonably effective continued occupation. As Huber said in the Island of Palmas Arbitration in the Tribunal of the Permanent Court of Arbitration, 1928: "Territorial sovereignty is, in general, a situation recognized and delimited in space, either by so-called natural frontiers as recognized by international law or by outward signs of delineation that are undisputed, or else by legal engagements entered into between interested neighbors, such as frontier conventions, or by acts of recognition of states within fixed boundaries * * * The growing insistence with which international law ever since the middle of the 18th century has demanded that the occupation shall be effective would be inconceivable if effectiveness were required only for the act of acqusition and not equally for the maintenance of the right."

Unlimited space sovereignty upward cannot conceivably meet these sound tests.

(2) Possible effective control so as to enforce national law is the primary limit of possible space sovereignty in areas seized or claimed without agreement. This test would not apply if general international agreements were reached to extend upward to a uniform height the territory of every subjacent state.

(3) In several recently published articles and addresses, (being put in the record at the request of members of the committee), I have suggested an agreement for an upper limit of about 300 miles, on the basis that this would include areas where "drag" affects free satellite flight, subject however to more information being available through the Geophysical Year activities as to the density of the upper atmosphere. I said recently, for example: "It seemed to me in 1956, and still does, that the subjacent state properly has sovereighty in the atmospheric area where airplanes and balloons can operate. These depend for their lift on the existence of fairly dense gaseous air in the true airspace. It also seemed then, and still does, that the area in which sufficient gaseous air exists to prevent free satellite flight might very well by agreement be deemed part of the airspace" (See p. 382, Journal of Air Law and Commerce, vol. 24, No. 4, autumn 1957 issue) As I have often said, the only agreement now existing is that sovereignty extends through the "airspace," and that the term "airspace" in the Paris convention of 1919 and the Chicago convention of 1944 was there meant to include only those parts of the atmosphere where gaseous air is sufficiently dense to provide aerodynamic lift for the only types of aircraft then in existence.

(4) Every state has the right to exclude all flight instrumentalities from its sovereign territorial space. Whether it would be justified in shooting down the intruder might depend on particular circumstances A similar problem as to aircraft intrusion is now before the World Court.

(5) Please see my suggestions as to three zones, recently restated in "Missiles and Satellites—The Law and National Policy," page 320, American Bar Association Journal, April 1958, vol. 44

(6) It would be preferable to fix the upward limit of national sovereignty by a new convention, adopted at a diplomatic conference, convened after careful advance preparation.

(7) Yes, an immediate declaration of policy should be made that the moon is "res communis"—not subiect to seizure by any individual state. Its intimate relationship with life on the earth through influence on tides and other physical phenomena on the earth, its possible future use—all show the need foı immediate recognition of its nonnational status. The United States should declare that the moon is open for exploration for the benefit of all, but that seizure would be an act of aggression against the interests of the international community

(8) The very limited upward rights of private owners were, in my judgment, clearly stated, so far as American law is concerned, in the Causby case decided by our Supreme Court in 1946 (328 U. S. 256). The Court held that the old "cujus est solum" doctrine "has no place in the modern world."

(9) The answer is "Yes"—this is the generally accepted modern rule.

(10) The solutions appearing in my original statement dealt with bases on which I felt agreement might be reached as to the upper limit of sovereignty. Certainly national defense criteria would also be considered before the United States took any final position—again indicating the advisibility of long-range research to explore every avenue of approach toward solution of our space problems.

(11) My original statement as to the moon was not properly framed. I have amended the statement on page 2532 of the transcript to show that I was discussing future international agreement. However, my views as to the necessity of separately declaring that the moon is "res communis" are amplified above in answering question No. 7

(12) This involves a Government military policy decision which I do not feel qualified to answer.

(13) As I said in my original statement, satellites and spaceships, in my judgment, are not within the definition of "aircraft" in the Air Commerce Act. Doubt certainly exists as to whether rockets or missiles are included. They are generally, so I am advised, designed for flight beyond the "air"—not in the "air."

(14) The constitutional basis for space agency legislation should be put on as broad a foundation as possible—particularly as to potential commerce, and effect on foreign relations.

(15) See my answer to question No. 1. In my judgment, mere military power to shoot down a foreign satellite at some great height is not the kind of continued effective occupation which a show of national sovereign control will demand. The latter part of the question raises again what I tried to indicate at the hearing—we may be faced with a crisis after the IGY year in view of the fact that the United States (as I understood Mr. Becker's testimony), has not committed itself as to whether future satellite upper space flights do or do not violate the territorial space of subjacent states.

Questions By Representative Keating

QUESTIONS FOR WITNESSES (NATIONAL SOVEREIGNTY IN OUTER SPACE)

1. Has our scientific progress into space raised legal problems which are so serious and imminent that we should take steps to meet them now?
2. Would it be better to "wait and see" before we begin to formulate the rules of the road?
3. Could the application of existing laws or treaties determine who owns space or certain parts of it?
4. Has the principle established at the Paris Convention of 1919—that every power has complete and exclusive sovereignty over the airspace above its territory—been rendered obsolete?
(a) What is the accepted meaning of the term "airspace"?
(b) Does this term need redefining?
(c) Do we need new terms to establish zones in which different rules should govern?
5. Would you favor the application of the law of the high seas to outer space?
6 Do you believe that by our participation in the IGY satellite program we in effect gave informal recognition to the principle of freedom of outer space?
7 Do you think the United States should make a formal "freedom of outer space declaration" now?
8. Do you favor an international agreement that outer space be the common property of all nations? Should this be accomplished through the U. N.?
9. Do you think some international organization, such as the U. N., should control outer space? Is it too early to push for this now?
10 Do you believe that the exploration of outer space should be conducted on an international level through some agency such as the U. N.?
11 What steps do you think the United States should take now to bar the use of outer space for military purposes?
(a) Should we press for negotiations now?
(b) Through the U. N.?
(c) Have you thought of any sort of inspection system as a safeguard?
(d) How could it best be enforced?
12. What is the present international law with respect to occupation and discovery?
13. Is this law suitable or adaptable to discoveries of and landings on celestial bodies such as the moon or Mars?
14. What new laws do you think are necessary? To avoid future disputes should they be agreed upon now? Can this best be accomplished through the U. N. or by negotiations and treaties outside the U. N.?
15. Would you favor international control of these celestial bodies? By the U. N.?
16. Has thought been given to the possibility that these bodies may be inhabited? How would we deal with intellectual beings?
17. With satellites orbiting the earth, and with talk of rockets to the moon, space platforms and other vehicles in space, are present laws adequate to govern problems of rights and liabilities as between nations, and between nations and individuals that may arise?
(a) What about liability for midair collisions, misguided missiles, etc?
(b) What about the rights of a launching nation to a downed satellite or rocket?
18 Does space travel pose any legal problems with respect to communications, navigation, air routes and terminals, and traffic control?
19. What action should Congress take now to meet and solve these problems?
(a) Would you favor a separate, special committee or joint committee devoted to the legal as distinguished from the scientific aspects of space exploration?
(b) Or should these problems be handled by one committee devoted to all space problems?
20 In view of the international character of so many of those problems, should they be left to the State Department to solve through the normal diplomatic channels?
21. If you believe the legal problems should be handled by the Space Agency suggested by the President, or one similar to it, should special provision be made for negotiation of these matters by the State Department?
22. The civilian space agency bill refers to terms such as "outside the earth's atmosphere", but does not define them Should there be definitions written into the bill?

ANSWERS OF JOHN C. COOPER TO MR. KEATING'S QUESTIONS

(1) Satellite launchings, in my judgment, require early decisions as to the legal status of the areas in which satellites are put in orbit. If such areas are part of territorial space, one set of principles will apply dealing with the well-established rules applicable to the right of each state to control movement in its territory. If such areas are not territorial space, a beginning should be made as to how, when, and by whom applicable rules should be adopted and then enforced

(2) It is too early to formulate rules of the road. I prefer Professor McDougal's Modest Proposal, as outlined in the January 1957 American Journal of International Law (vol. 51, No. 1, p. 74, text p. 77) where he suggested, as a beginning, the following program· "each state about to launch a satellite to register its intent to do so with an international agency, to file a flight plan with such agency, and to file a description of the satellite's load, weight, size, etc "

(3) Existing laws and treaties are not much help without an agreed definition of "airspace."

(4) The principle of airspace sovereignty should still stand

(*a*) As to my view of what the Paris convention meant by "airspace," see my answer to Mr. Feldman's question No. 3.

(*b*) The term has never been defined

(*c*) I prefer new terms, I would particularly prefer to use "territorial space" instead of "airspace" to define the areas in which the state below has complete and absolute sovereignty.

(5) The law of the high seas as to rights of freedom of navigation and rights of self-defense and self-protection could be applied to the areas of space beyond territorial space. Beyond this there may be difficulty in applying sea law to usable space

(6) The legal effect of the course of conduct of the United States in participating in the IGY satellite program presents grave difficulties As I pointed out at the American Bar Association meeting last February, "international conduct during the past 3 years is leading to the acceptance of the rule that areas of space, where there is not atmosphere of sufficient density to create drag or otherwise affect flight, are beyond the sovereignty of any state " Certain European jurists have expressed the categorical opinion that the freedom of "outer space" has now been accepted. In this connection Mr. Becker's testimony is of major importance. It is the first authoritative statement which I have seen that the United States does not feel itself committed for the future beyond the IGY. This should be carefully noted by the committee.

(7) First there must be a definition of outer space by the United States, then all of the problems involved from political, military, and legal points of view need full examination I would prefer to see the Space Agency set up before the United States commits itself further

(8) Yes, if by "common property" is meant that it is open to permanent peaceful use by all members of the international community. Since the breakdown of the Geneva Sea Law Conference, I am not as much in favor as I once was of a U. N. agreement as the bases of future action

(9) Too early, in my judgment, to determine how future control should be exercised

(10) For the present I would prefer national exploration under a general agreement banning military use

(11) I would prefer a diplomatic conference after careful preparation. The type of practical inspection system to be established needs extensive further study.

(12) Please see my answer to Mr. Feldman's question No. 1. My own view is that Huber's opinion in the Island of Palmas case is still the best statement of the law as I understand it.

(13) Probably, unless, as I hope, an early decision will be made that the moon is "res communis" and therefore outside the category of lands that may be occupied as new national territory. Also doubt must exist as to whether anyone could "discover" the moon—even its nonvisible side

(14) My primary concern is an early decision as to the extent upward of territorial space. Until then, other new laws might be useless.

(15) By an international agency to permit freedom of exploration—not seizure or other use for national purposes.

(16) Have given the matter no consideration.

(17) (*a*) Rules of the road must eventually be worked out, and also liability questions. One of the most difficult questions will be to differentiate between rules in territorial space and in outer space. Particular consideration must be

given to the powers of the International Civil Aviation Organization to adopt binding rules for aircraft flight over the high seas under article 12 of the Chicago convention. A decision must be made as to how high these rules will apply and as to what flight instrumentalities will be included.

(b) While property rights may be reserved, certainly any international inspection system should permit the state where the satellite or rocket has landed to make a full examination of the fallen object.

(18) Extremely difficult problems; for example, use of designated radio frequencies, plain codes for communication as a part of any inspection system, noninterference with other forms of flight when leaving or arriving on the earth, etc.

(19) I am strongly in favor of a single agency to study the political, legal, and scientific questions.

(20) and (21) A properly constituted Space Agency should study all of these problems and make its recommendations to the President. Such diplomatic action as he might determine would be implemented through the State Department.

(22) The term "atmosphere" is very vague and unsatisfactory. I would prefer "territorial space" and "outer space" with mutually exclusive definitions. It has been estimated that stray molecules of gaseous air may exist at vast distances out into space. If this is what is meant by "atmosphere," the term "outside the earth's atmosphere" is legally useless.

Outline of Testimony of Loftus Becker, the Legal Adviser of the State Department

1. Is there any accepted principle of international laws relating to space?

There is. Under article 51 of the United Nations Charter, the members of the United Nations expressly reserved their "inherent right" of individual or collective self defense against armed attack.

The origin of an armed attack against the United States or the particular point in space through which it would have to pass in order to reach the United States (or one of its collective security allies) is immaterial. The United States is, of course, prepared at all times to react in order to defend itself against an armed attack, even though such attack might originate in territory or in airspace which we recognize as being subject to the sovereignty of another state. A fortiori the United States is prepared to defend itself against an armed attack originating in, or passing through, space outside the earth's atmosphere. If and when the United States takes such action, it will be exercising not a unilaterally asserted right, but rather a right established by accepted international law, as defined in the charter of the United Nations.

2. Has the United States recognized any top or upper limit to its sovereignty?

The answer is "No."

Entirely aside from article 51 of the United Nations Charter, the United States has never taken the position that its sovereignty (or any related rights that it might assert) has an upper limit.

A number of commentators have laid great emphasis upon the fact that such international agreements as the Chicago Convention of 1944 (TIAS 1591), like the earlier Paris Convention of 1919 (11 LNTS 173), recognized that each of the parties thereto "* * * has complete and exclusive sovereignty of the air space above its territory." From this they infer a negation of the principle that any state has sovereignty over space outside the "airspace" above its territory. I cannot agree that the significance of international agreement upon a principle such as this can be evaluated without regard for the context in which it was made the subject of agreement. To stipulate that a state has "complete and exclusive" sovereignty within certain defined limits is not to say that it has no rights above those limits; the only reasonable inference from such a statement is that no agreement has been reached as to what, if any, rights may be recognized above such limits.

It is important to note that there is nowhere in the Chicago Convention of 1944, or other international agreements comparable thereto, any definition of what is meant by the term "airspace."

A number of those who have commented on what should be the law of space have suggested definitions for this term. I do not wish to take, nor has the State Department ever officially taken, a definitive position as to how this term "airspace" should be defined. I think, it important to note, however, that one of the suggestions that has been made in this regard is that the "airspace" should be

defined to include that portion of space above the earth in which there is any "atmosphere." I am informed that astronomically the earth's "atmosphere" extends 10,000 miles above its surface. While the Department of State has taken no position upon this question, I do think it important to point out that one rational definition of "airspace" would enable us to maintain that there is a body of international law applicable up to 10,000 miles from the surface of the earth. That would seem to afford us sufficient elbow room for discussion.

It is therefore important to note that although the United States in its domestic law, as well as in such international agreements as the Chicago Convention of 1944, has plainly asserted its "complete and exclusive sovereignty over the airspace above its territory," the United States has at no time conceded that it had no rights in the higher regions of space.

One rationale for this position, which seems to me self-sufficient, was that the United States had no need to define its position with respect to what rights, if any, it might possess outside the earth's atmosphere until such time as mankind had demonstrated a capability of existing outside the atmosphere.

Even after such a capability is demonstrated, there will be no imperative requirement in international law that the United States make any claims of sovereignty in order to protect its rights.

An apt analogy is afforded by the Antarctic. There, for many, many years, the United States has been engaged in activities which, under established principles of international law, without any question whatsoever, created rights upon which the United States would be justified in asserting territorial claims, that is to say, claims to sovereignty over one or more areas of the Antarctic. Notwithstanding this fact, the United States has not asserted any claim of sovereignty over any portion of Antarctica, although the United States has, at the same time, made it plain that it did not recognize any such claims made by other States Nonetheless, the United States has been consistent in asserting that under international law and practice, its activities on the Antarctic continent have entitled it to rights in that area which it has at all times expressly reserved. It is the position of your Government, and, I believe one well founded in international law, that the fact the United States has not based a claim of sovereignty over one or more areas of Antarctica upon the activities it has engaged there, in no way derogates from the rights that were established by such activities

So, too, in outer space, the United States has already engaged in activities which, it could be asserted, have given to it certain rights, as distinguished from those States who have not engaged in such activities. Up to this time, the United States has made no claims based upon such activities. As in the situation with respect to Antarctica, this should not be interpreted as any concession of any kind whatsoever on the part of the United States that its activities have not given it certain rights in space which, in turn, could be relied upon as the basis of claims of sovereignty.

3. Should the law of space be codified at this time?

The President, the Secretary of State, and Ambassador Lodge have several times suggested to the U. S. S. R , which, to date, is the only other state that has demonstrated a capability of placing objects in orbit in space, that we consult with the objective of insuring that mankind's activities in space be devoted exclusively to peaceful purposes. These proposals have included any and all activities in space, whether or not they involved putting an object in orbit. To the extent envisaged by these proposals, we believe that the sooner that agreement is reached, the better.

As you know, the tendency of development of the common law, as applied in the United Kingdom and the United States and in a number of other countries, has been on a case to case basis Speaking very generally, it has been felt that the soundest way to progress in the extremely complex field of the law is by means of specific decisions, on specific questions, presented by specific fact situations.

Even in those States which apply the principles of the civil law, it is recognized that a body of law can only be created upon a broader body of ascertained fact.

Moreover, there are very great risks in attempting to transmute a body of law based upon one determined set of facts into a body of law with respect to which the basic facts have not been determined. Accordingly, we view with great reserve any suggestion that the principles of the law of the sea should, prior to the ascertaining of many more facts with respect to conditions in space, become the law of space.

Basically, it is the position of our Government that the law of space should be based upon the facts of space and that there is very much more that we have to

learn about the conditions existing in space, before we shall be in a position to say what shall be the legal principles applicable thereto.

4. The significance of a definition of the airspace

Many commentators have suggested that it is imperative that at the earliest possible moment we shall have an internationally agreed upon definition of airspace. This assertion is related to the suggestion that such definition is requisite in order to delimit areas of national sovereignty. I believe that from what I have already stated, it will be apparent that I do not share in this view, nor has the United States Government ever conceded that its sovereignty upward was restricted to the airspace above its territory There are other aspects of this question, with respect to which the significance of this dividing line may be less important that has heretofore been asserted

Public announcement has been made of an "X-15" which is designed to operate both inside and outside the earth's atmosphere as defined by some of the commentators Moreover, all objects which orbit around the earth, whether or not they do so within or outside the atmosphere, or partly within and partly outside the atmosphere, have characteristics of operation which distinguish them sharply from other objects which may, for a period of time, pass through space.

As you are undoubtedly well aware, a number of systems of private law relate to the characteristics of the activities upon which one is engaged. For example, in our own law we have one set of rules applicable to the activity of mining, another applicable to the extraction of petroleum and like materials, and still another applicable to subsurface waters, although all three activities, in general, relate to man's actions or interests below the surface of the earth

Here again, one of the possibilities to which we shall have to give serious consideration is whether the performance of a particular space vehicle is sufficiently distinguishable so as to justify applying to it a set of rules which are different and distinct from those that we apply to other space vehicles having different operating characteristics.

To take an analogy from the law of the sea, while there have been certain principles applicable to all seagoing vessels, there has always been a distinction between the rules applied to sailboats and those applied to boats propelled by one or another method of mechanical propulsion.

5. Property rights

A number of commentators have stressed the necessity of developing an internationally recognized set of principles of property rights applicable to space vehicles Two of the questions frequently raised are first, as to the right of the subjacent state to protect itself from injury from such a vehicle landing on its surface or its inhabitants, or second, as to the right of such a state to damages for injury resulting from such activities. Another question in this regard which has been recently discussed in the press in connection with the Soviet claim that a portion of its satellite had landed on United States soil, was whether or not the state which initiates the flight of a space vehicle retains a property right in such vehicle in the event that it comes to earth again.

Although there is no generally accepted international code with respect to space vehicles as such, I would suggest that existing international law provides a set of principles which could be made applicable, until such time as we find it necessary to recognize specialized principles.

Assuming that the problem of reentry has been overcome, so that a space vehicle does not disintegrate before returning to earth, such a vehicle must, of necessity, pass through the airspace in order to return to earth. It is a recognized principle of international law that the sovereignty of a state with respect to the airspace over its territory and its territorial seas is complete and exclusive. This means that the vessels of another state, including those which are unmanned as well as those that are manned, are not entitled to enter upon such airspace without the permission of the sovereign state.

If the permission of the subjacent state is to be obtained, it may be conditioned by undertakings with respect to liability for any damage which may result therefrom. If it is not obtained, the tortious nature of the entry upon the airspace of the subjacent state would seem to make the initiating state a guarantor with respect to any damage resulting from its unjustified activity.

As respects the ownership of a space vehicle returning to earth, some commentators have suggested that, at least as respects unmanned space vehicles, the appropriate analogy is the bullet, ownership of which is abandoned by the act of firing. An alternative rationale would be that any such vehicle entering the airspace of a sovereign state without the latter's permission should be placed

in the category of smuggled goods which may not only be confiscated upon discovery, but with respect to which action may be taken outside the territory or the territorial waters of the state in which the same are to be introduced.

INTERNATIONAL AIR LAW

A lecture delivered by Mr. John C. Cooper, Member, Institute for Advanced Study, Princeton, N. J., at the United States Naval War College, Newport, R. I., December 20, 1948

Air law has been defined as "the whole of the rules which govern the airspace and its utilization for the purpose of aviation" (Goedhuis, Air Law in the Making, The Hague, Nijhoff, 1938) The difficulty with this definition today is that technical progress now requires that we consider both airspace and certain parts of space beyond as scientifically practical mediums of flight Nor can we limit the means of flight with which air law must deal to such instrumentalities as the normal types of aircraft usually operated in the "airspace." Rockets are now being propelled seventy miles and more into space above the surface of the earth, far outside of what we ordinarily refer to as "airspace" and its "atmosphere" It is suggested that the term "flight space" might better be used in place of airspace to indicate all that space above the earth's surface used or usable as a medium of man-made or controlled flight. Perhaps the definition of air law might then be restated as "comprising the whole of the rules governing flight space and its utilization as a medium of flight for aircraft or other self-propelled and man-controlled devices."

Such a definition has the advantage of directing attention to the two basic problems of air law—its concern with the legal status of space and the legal regulation of flight. It is obvious that until we know whether flight space is part of the national territory of the state lying below it, or free of all control and usable by all states, it is quite impossible to determine the rules applicable to the regulation of flight in such space. Hence air law must first determine the legal status of flight space over the various parts of the earth's surface, such as the national territory of sovereign states below and the high seas, and having determined such status, it must then provide the rules for the regulation of flight.

As to the first of these problems, it is the function of international air law, as law governing the relations between states, to determine what parts of flight space can become or are parts of the territory of sovereign states and what parts of such space must be free for the use of all peoples. Exactly the same problem developed in the law of the seas Complete confusion and strife existed between nations as to the right to control the high seas until customary international law was tacitly accepted under which it is now agreed that the high seas are not and cannot become part of the sovereign territory of any state and must be open and free to the navigation of all states. As pointed out by Kelsen (General Theory of Law and State, Cambridge, Mass., Harv Univ Press, 1945, p 349) "each state can claim as its 'territory' only a part of space and as its people only a part of mankind." Any interference by one state with these spheres of another state is a violation of the rights of the other state Hence no single state can determine what part of space is of the character which it has the right to include within its territory, and only international law, which governs the relations between states, can provide the applicable rules.

International air law has recognized these problems It has sought first to determine rules acceptable to the community of states as to the legal status of flight space and then provide international regulations of flight through such space as is not part of the territory of individual states, and also, by such international legislation to provide certain rules to be applied by all states even as to flight within their territorial flight space Agreement exists as to the principles covering the legal status of the "airspace." The problem is new as to the legal status of space beyond the airspace. Agreement also exists among most states as to rules regulating flight in time of peace. No substantial agreement exists as to such regulation in time of war.

To demonstrate the existence and nonexistence of international air law covering these various spheres of international relations, an examination of the Convention on International Civil Aviation signed at Chicago in 1944 and now in effect will be useful.

LEGAL STATUS OF FLIGHT-SPACE

The Chicago convention is now in force between most of the nations of the world with the notable exception of the Soviet Union. Articles 1 and 2 of that convention state presently accepted international air law as to the legal status of the airspace:

"*Article 1.*—The contracting states recognize that every state has complete and exclusive sovereignty over the airspace above its territory.

"*Article 2.*—For the purposes of this Convention the territory of a state shall be deemed to be the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection, or mandate of such state."

Several things are noteworthy in these articles: (*a*) They state existing International air law and do not legislatively create such law, because they recognize that "every state" whether a contracting state or not has exclusive airspace sovereignty over its territory; (*b*) there is no limitation as to applicability in peace or in war—it being clearly inherent in the convention that these statements apply in both, (*c*) No statement is made as to the status of airspace over the high seas.

The background history of these articles and the principles which they state are well known About the beginning of the present century, when control of flight through the development of dirigibles became a real possibility, an eminent French lawyer, Fauchille, raised the question as to whether states have territory in the air as well as on land and on water. An historic controversy developed, the details of which cannot be considered here, between the proponents of national sovereignty in the airspace and those who insisted that it should be free to air navigation as the high seas were free to surface navigation. No better statement of this controversy exists than that made by Prof. George Grafton Wilson in the Naval War College, International Law Situations for 1912 (pp. 68–70):

"The ideas in regard to the limits of aerial jurisdiction set forth by those who are giving special attention to this subject are not, however, in accord. It is natural that one group should maintain the ancient doctrine that 'the air is free.' Another group maintains that the domain of the air is exclusively in the subjacent state. A third group, between these, maintains that a certain zone of atmosphere above a state is within its jurisdiction, and beyond this the air is free. The height of this zone of jurisdiction is, however, a subject of considerable difference of opinion

"The argument has been advanced that the aerial domain of a state should be limited to a certain distance above its territory. It has been stated that the altitude which an airship might attain can be determined, but as the limits fixed in earlier estimates have been surpassed it seems unwise to attempt at present to establish such limits.

"Some think the height of the zone can be determined in a manner analogous to that of determining maritime jurisdiction. Some see unsurmountable difficulties in the use of this analogy. Of those who favor a zone theory some propose that the zone be determined by the limit of vision; some that the limit of effective control by arms be the determining factor; some that an arbitrary limit be agreed upon by the states of the world, and others advance other propositions."

The discussions to which Professor Wilson had reference were largely between lawyers. In a careful reexamination of practically all of the available material, beginning with the invention of the balloon in 1783 and continuing until World War I, I have been able to find no occasion in which a sovereign state disclaimed sovereignty in its airspace. It is my judgment that such sovereignty has always existed. In this view I think that I am supported by the great authority of Professor Wilson. In the same Naval War College publication referred to above, he noted the fact that regulations issued by state authority make it evident "that states assume that they have jurisdiction in the airspace above their territory." In summarizing his views and basing his remarks on a quotation from a decision by Mr. Justice Story in *Santissima Trinidad* (7 Wheaton 354) and repeating what he had said in a paper read before the American Political Science Association in 1910 (Aerial Jurisdiction, V American Political Science *Review*, 1911, p. 171), Professor Wilson said:

"It would seem that physical safety, military necessity, the enforcement of police, revenue, and sanitary regulations justify the claim that a state has jurisdiction in aerial space above its territory. This position also seems to underlie established domestic law and regulations, the decisions of national courts, the conclusions of international conferences, and the provisions of international conventions.

"It would seem wise, therefore, to start from the premise that air above the high seas and territory that is res nullius is free, while other air is within the jurisdiction of the subjacent state 'and that the exceptions to this rule are such only as by common usage and public policy have been allowed, in order to preserve the peace and harmony of nations and to regulate their intercourse, in a manner best suited to their dignity and rights,' and for these exceptions to the exclusive right of aerial jurisdiction of the subjacent state, international conferences should by agreement immediately provide" (Naval War College, International Law Situations, 1912, p. 71–72).

This remarkable statement, first made in 1910 and repeated in 1912, analyzes the basic question of international air law as it is now understood.

The first attempt at the Paris Conference of 1910 to agree on rules of flight was unsuccessful. At that conference there was wide difference between certain of the nations present as to the extent to which foreign aircraft might have privileges of flight in the airspace over national territory of the European governments which took part in the conference. But no government was there prepared to accept the theory that the airspace over its territory was not part of the domain and thereby not subject to its control. An examination of the minutes of this conference will bear out the statement just made (Conference internationale de navigation aerienne, Paris, May-June, 1910, Proces-verbaux de seances et annexes).

The concrete acts of the great European powers later affirmed their earlias apparent insistence on airspace sovereignty. Great Britain, in the Air Navigation Acts of 1911 and 1913, proclaimed its right to set up various prohibited areas in its airspace where no foreign aircraft might fly and to control the terms under which any foreign aircraft might otherwise enter the airspace over British surface territory. By an exchange of notes in 1913 between the French and German Governments, it was agreed that military aircraft of one nation could enter the airspace of another only on invitation, and that civil aircraft of one nation must obtain a special permit from a consul of the other nation before starting out on a trip to the latter's territory. Provisions were also included for prohibited areas over which the aircraft of the other nation could never fly.

The British Air Navigation Acts and the French-German air traffic agreement could not have been entered into except on the theory that each of these powers claimed the full right to control, as against other nations, the airspace over its land territory. This is the exercise of external or national sovereignty in international law.

The outbreak of World War I affirmed the continued claim of airspace sovereignty by the European nations In a letter handed by the German Ambassador to the French Foreign Minister on August 3, 1914, in which it was stated that the German Empire considered itself at war with France, one of the alleged hostile acts charged by Germany to be one of the direct causes of war was the fact that French military aviators were said to have been guilty of hostile acts on German territory and that they had "openly violated the neutrality of Belgium by flying over the territory of that country." In other words, Germany insisted that the airspace over Germany was part of German territory and that the airspace over Belgium was part of Belgian territory—that the flight of French aircraft into Belgian airspace, even without performing any hostile acts against the Belgian inhabitants, constituted an invasion of Belgian territory and a violation of Belgian sovereignty and its internationally guaranteed neutrality

Immediately after the outbreak of war, various nations of Europe closed their air boundaries. During the course of the war neutral states required foreign belligerent aircraft flying into their airspace to land and be interned just as they also required foot soldiers, under international rules of war, to be interned when they crossed land boundaries into neutral territory

During the meeting of the Peace Conference following World War I, an aeronautical commission was organized and charged with preparing a convention for the regulation of air navigation Its Legal Subcommission (on which the United States was represented) in submitting a draft of the proposed convention, made the following authoritative statements in its report:

"The first question placed before the Subcommission was that of the Principle of freedom or of sovereignty of the air

"* * * the opinion expressed in the Legal Subcommission is favorable to the full and exclusive submission of the airspace to the sovereignty of the subjacent territory. It is only when the column of air hangs over a res nullius or communis, the sea, that freedom becomes the law of the air

"Therefore, the airspace is part of the legal regime of the subjacent territory. Is this territory that of a particular state? Then the airspace is subject to the sovereignty of that state. Does it escape all sovereignty as the free sea? Then the airspace is also free above the sea, as the sea itself

"It results then that, by virtue of its sovereignty, the subjacent state, within its borders, can forbid flight and, with greater reason, landing."

The convention drafted by this Subcommission of the Aeronautical Commission was signed and came into effect as the Paris Convention of 1919 "relating to the regulation of aerial navigation." It stated in article 1 the basic problem of airspace sovereignty:

"The high contracting parties recognize that every power has complete and exclusive sovereignty over the airspace above its territory.

"For the purpose of the present Convention the territory of a state shall be understood as including the national territory, both that of the mother country and of the colonies, and the territorial waters adjacent thereto "

The United States was represented on the Aeronautical Commission and took an active part in insisting on the adoption of the theory of airspace sovereignty. Its delegates signed the convention, but for various reasons, particularly because of the indirect relation between the Paris Convention and other treaties acknowledging the authority of the League of Nations, the Paris Convention was not ratified by the United States This nonratification had nothing to do with the acknowledgment by the convention of airspace sovereignty as the fundamental precept of international air law The convention was later ratified or adhered to by most of the nations of Europe except the Soviet Union and Germany, also by the British Dominions and Japan, and certain Latin American countries. Both Germany and the Soviet Union, through separate statutes insisted on airspace sovereignty and their consequent right to admit or exclude foreign aircraft into their territorial airspace

Such was also the position of the United States. Every recorded official act of the United States Government has indicated its complete acceptance of the doctrine of airspace sovereignty and its insistence on its right as a sovereign state as against foreign nations to determine whether the aircraft of such foreign nations may be admitted to or excluded from use of the airspace over the United States. In 1916, for example, the United States took part at an inter-American conference at Santiago, Chile, at which resolutions were adopted providing that states should have sovereign rights in the airspace over their respective territories. During World War I, on February 18, 1918, President Wilson issued a proclamation inaugurating a licensing system under which no flight could take place except pursuant to a license to be issued by a joint Army and Navy board if the flight was to pass over or near military installations "or any place or region within the jurisdiction or occupation of the United States which may be designated by the President as a zone of warlike operations or of warlike preparations " In the same proclamation, the President designated as a zone of military operations and preparation the whole of the United States and its territorial waters and insular possessions In other words, the proclamation assumed complete national control over all the airspace above the lands and waters of the United States.

To the same effect were the provisions of the Air Commerce Act of 1926, the first Federal statute regulating flight in interstate and foreign commerce. In section 6 of that statute is included a congressional declaration "that the Government of the United States has to the exclusion of all foreign nations complete sovereignty of the airspace over the lands and waters of the United States including the Canal Zone " In the House Report 572, 69th Congress, 1st session in which the bill was reported which became the Air Commerce Act of 1926, it is pointed out the "the legal features of the bill have their foundation in existing principles of law," and that "the declaration of the sovereignty of the United States as against foreign nations in the airspace above the United States is based upon a similar declaration found in the International Air Navigation Convention " In other words, the United States, although it did not ratify the Paris Convention, accepted the statements in article 1 of that convention as to airspace sovereignty as being a correct acknowledgment of the existence of a principle of customary international law

No legislative action in the United States has subsequently in any manner affected or changed this policy As a matter of fact the policy has been reaffirmed.

In 1928 the United States assisted in drafting and later signed and ratified the Havana Convention known as the Pan American Convention on Commercial Aviation which in article 1 recognizes "that every state has complete and exclusive sovereignty over the airspace above its territory and territorial waters." Again in 1938, by the adoption of the Civil Aeronautics Act, the same principle was affirmed

It is apparent from this recapitulation of the development of international air law airspace sovereignty principles up to and including the adoption of the Chicago Convention that certain rules may now be considered in force:

(1) Each state has complete and exclusive sovereignty over the airspace above its territory

Airspace as here stated is believed to mean only that part of space which is filled with air and not the space beyond In commenting on the legal history of the Air Commerce Act of 1926, Mr Frederic P. Lee, legislative counsel for the

United States Senate at the time of the adoption of the act, indicates that the term "airspace" should be construed as that part of space above the earth's surface filled with air and that any interpretation of the term "airspace" "other that such literal interpretation involves the construing of airspace as synonymous with space." (Civil Aeronautics. Legislative History of Air Commerce Act of 1926, corrected to August 1, 1928 Washington, U. S. Government Printing Office, 1943.) If all space was intended, the results are absurd. Therefore, no international air law can be said to govern at this time the use of space beyond the airspace and the problem requires future international consideration. Perhaps by analogy the rules now existing in airspace may be extended beyond into such additional areas of flightspace as are reasonably subject to control by the subjacent State.

(2) Territory, for the purposes of airspace sovereignty, includes territorial waters and territory under mandates

Airspace over territorial waters is in exactly the same status as airspace over land territory. No privilege, right or easement is acknowledged in favor of foreign aircraft in such airspace over territorial waters. International air law has not accepted the doctrine of innocent passage which gives foreign surface ships certain rights of passage in territorial waters, without specific agreement of the adjacent sovereign state. As a result the air boundaries of a state are at the edge of its territorial waters and no aircraft of a foreign state may fly into such airspace over territorial waters without the specific permission of the adjacent state. This indicates the danger in seeking to create rules of air law by analogy from rules of maritime law

The Chicago convention was adopted before the United Nations Charter was adopted at San Francisco The Chicago convention includes mandated territory (Legaue of Nations mandates) within national territory for the purposes of the convention. Unfortunately trusteeships under the United Nations Charter are a different type of legal entity and further international consideration must be given to determine the status of airspace over United Nations trusteeships, unless it be clearly set out in the terms of the trusteeship agreement.

(3) Airspace over the high seas is free to the use of all states

The basic principle of international air law is that the airspace has the same legal status as the surface of the earth beneath it Airspace over land areas, inland waters, bays, or gulfs under national sovereignty and territorial waters of any state is part of the national airspace of such state Airspace over the high seas or other parts of the earth's surface not subject to the national sovereignty of any state is free to the use of all nations. As a result freedom of the air really exists to the same extent as does true freedom of the sea. Where the rules of international maritime law and the rules of international air law differ radically is on the right of passage through territorial waters and into open ports as accorded by maritime law to foreign surface vessels, and as denied in the airspace over such territorial waters and ports to aircraft of foreign nations except with the specific permission of the state concerned This freedom of airspace over the high seas was evidenced in the report of the Aeronautical Commission at Paris referred to earlier. The freedom of the airspace over the high seas is further evidenced by the provisions of article 12 of the Chicago convention which contemplates that each state shall adopt its own measures to regulate flight in the airspace over its own territory and will undertake to keep these regulations uniform with those established under the convention, but as to the airspace over the high seas "the rules in force shall be those established under this convention." In other words, no single state has the right to legislate flight rules over the high seas, but the adoption of such rules may be accomplished by international legislation.

(4) Every sovereign state has complete control of the airspace over its territory, has the exclusive right to fly in that airspace, and may exclude all foreign aircraft or admit them on such terms as it sees fit

This means that landlocked states such as Switzerland and Bolivia may fly beyond their borders only with the consent of neighboring states. Island states such as England and Scotland combined, Australia, New Zealand, the Philippines, and Iceland, may fly out of their borders and over the high seas as and when they may desire. The United States may fly from its shores over the Atlantic, the Pacific, or the Gulf of Mexico at will, but may fly across its other borders into the airspace over Canada or Mexico only with the permission of such border states.

REGULATION OF INTERNATIONAL FLIGHT UNDER THE CHICAGO CONVENTION

Judge Manley O Hudson has stated that "the term 'international legislation' would seem to describe quite usefully both the process and the product of the conscious effort to make additions to or changes in the law of nations." (Hudson, International Legislation, I, 1919–21, p. xiii of introduction.) The Paris convention of 1919, the Habana convention of 1928, and now the Chicago convention of 1944 are typical examples of such international legislation. International flight developed too fast to provide for the gradual process of the growth of customary international law as a basis of regulation. The drafting of the Paris convention of 1919 at the end of World War I was a conscious and studied effort to provide for the regulation of flight in time of peace Such was also the Habana convention, designed to be effective in the Western Hemisphere. Both of these have now been superseded by the Chicago convention. The first two articles of this convention, as I have indicated earlier, restate prior existing international law as to the legal status of flight space. The only international legislation included in these first two articles might possibly be said to be the extension of the territory of a state to include lands under its sovereignty, protection, or mandate. These provisions might be considered international legislation. Otherwise it is simply an affirmation of a prior existing and accepted doctrine. But the balance of the convention is true international legislation. It represents a conscious effort to make additions to, or changes in the law of nations Time does not permit me to discuss more than a very few of its provisions. Some are, however, of seeming interest to the naval profession

Article 3 (state aircraft).—The convention is normally applicable to civil aircraft and not to state aircraft. All aircraft used in military, customs, and police services "shall be deemed to be state aircraft." However, the convention does provide that "no state aircraft of a contracting state shall fly over the territory of another state or land thereon without authorization by special agreement or otherwise, and in accordance with the terms thereof." This means that no aircraft used in the military services may be flown into or over the territory or territorial waters of another state without special permission having been received, even though as between the two states concerned an agreement may exist granting reciprocal flight privileges to nonmilitary aircraft.

Article 5 (nonscheduled flight)—Under this article the contracting states exchange privileges for their aircraft not engaged in scheduled services. It must be noted that this article applies only to aircraft of contracting states. This means that any state renouncing the convention is thereby released from any obligation that it may have to allow foreign aircraft to enter its territory. Had the convention intended to evidence the general freedom of flight internationally, the privilege of flight would have been made available to aircraft of all states and not to aircraft of contracting states.

Article 6 (scheduled air services).—This article provides that "no scheduled international air service may be operated over or into the territory of a contracting state except with the special permission or other authorization of that state, and in accordance with the terms of such permission or authorization." The contents of this article provide further evidence of the acceptance of the basic international air law rule cited above that every sovereign state has complete control of the airspace over its territory and may exclude all foreign aircraft or admit them on such terms as it sees fit. It is because of the existence of this article that the states which are parties to the Chicago convention have negotiated various bilateral agreements and have sought, as yet without result, to agree on a general multilateral agreement for the exchange of flight privileges in international commercial air transport.

Article 8 (pilotless aircraft).—Article 8 provides that "no aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting state without special authorization by that state and in accordance with the terms of such authorization." It will be noted that this important paragraph makes no mention of airspace It is a definite agreement as between the contracting parties that no type of aircraft flown without a pilot may be flown over the territory of such contracting states (at no matter what height) without special authorization The presence of this article in the convention may be considered together with the failure of articles 5 and 6 to mention airspace, as evidence only of a treaty agreement between the parties to the convention regarding the use of all flight space over their respective territories It does not appear to constitute a statement of a general rule of international law as to limitations in the use by all states, irrespective of the convention, of that part of flight-space above the airspace

Article 9 (*prohibited areas*).—This article provides that "each contracting state may, for reasons of military necessity or public safety, restrict or prohibit uniformly the aircraft of other states from flying over certain areas of its territory, provided that no distinction in this respect is made between the aircraft of the state whose territory is involved, engaged in international scheduled airline services, and the aircraft of the other contracting states likewise engaged." This provision was inserted in the convention so that, as between contracting states, military or other prohibited areas could not be used as a screen for discrimination between the international services of the states concerned and other states. It is not considered that anything in this article limits the right of states to set up prohibited areas for any reason that they may desire as against noncontracting states.

Article 12 (*rules of the air*).—Under this article each contracting State undertakes to keep its own regulations as to use of airspace over its territory "uniform, to the greatest possible extent, with those established from time to time under this convention." This provision constitutes the greatest difference between the Paris Convention of 1919 and the Chicago Convention of 1944. Under the former convention, various annexes, including those providing for rules of the air, could be adopted and made part of the convention without reference back to member states for ratification. Doubt always existed whether the United States and certain other American Republics could legally accept the Paris Convention for this reason, as in the United States and certain other American Republics having similar constitutional provisions, every treaty amendment requires constitutional reratification. The Chicago Convention is so drawn that the rules of the air and other flight regulations, when adopted by the International Civil Aviation Organization, are not ipso facto enforcible as to flight in national airspace, but come into force as to such flight only when adopted into the local regulations by the several states. But, as indicated earlier, this same article 12 provides that over the high seas the rules in force shall be those established by the International Civil Aviation Organization under the convention. Such rules do not require separate state ratification.

Articles 17–21 (*Nationality*).—These articles provide that aircraft shall have the nationality of the State in which they are registered, that an aircraft cannot be validly registered in more than one state, and that aircraft engaged in international air navigation shall bear appropriate nationality and registration marks. Nothing in these articles or elsewhere in the convention legislates on the difficult and doubtful point as to whether this "nationality" means more than similar international regulations requiring automobiles to carry nationality license marks for identification. The convention does not settle the question as to whether aircraft have the somewhat fictional character of being part of the territory of the state of its flag, which a merchant ship supposedly possesses, when proceeding abroad. This entire question is still open and will need further international legislation.

The foregoing provisions of the Chicago Convention appear to be especially pertinent in a general discussion of international air law. My failure to mention other specific provisions of the convention does not mean that the remaining parts of the convention are unimportant or need not be carefully considered by anyone dealing with international aviation problems.

REGULATION OF INTERNATIONAL FLIGHT IN TIME OF WAR

Dealing with international air law in time of peace is comparatively simple. Most of its salient provisions are evidenced by international conventions or can be easily ascertained along the lines of the earlier parts of this discussion, but as to the rules applicable in time of war, the situation is quite different.

Whenever a rule is stated as being applicable to the relations between States in time of war and involving the use of any kind of flight, I would suggest that this rule be subjected to the following test: Is it of such character you could prove its existence and rely upon it in a case before the World Court? You will doubtless recall that the Statute of the International Court of Justice (the World Court), as established by the Charter of the United Nations, definitely instructs the Court as to the sources from which it may determine the existence of international law. Article 38 of the Statute of the Court provides as follows:

"1. The Court, whose function is to decide in accordance with international law such disputes as are submitted to it, shall apply:

(*a*) international conventions, whether general or particular establishing rules expressly recognized by the contesting states:

(*b*) international custom, as evidence of a general practice accepted as law:
(*c*) the general principles of law recognized by civilized nations:
(*d*) subject to the provisions of article 59, judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law."

Article 59 referred to says that the decision of the Court has no binding force except between the parties and in respect to that particular case.

In applying this statute it is suggested that you also recall that the Permanent Court of International Justice in deciding the celebrated case of the S. S. Lotus (2 Hudson, World Court Reports (1935), p. 20) said, with reference to custom or usages as a source of international law, that "the rules of law binding upon the States therefore emanate from their own free will as expressed * * * by usages generally accepted as expressing principles of law and established in order to regulate the relations between these coexisting independent communities or with a view to the achievement of common aims." It is also well to recall, when considering the "teachings of the most highly qualified publicists" that the Supreme Court of the United States in the case of *The Paquete Havana* (175 U. S. 677) warned that the works of jurists and commentators on the subject of international law "are resorted to by judicial tribunals not for the speculations of their authors concerning what the law ought to be, but for trustworthy evidence of what the law really is."

Considering first the applicability of international conventions, the Chicago Convention definitely authorizes contracting states, in article 89, to disregard its provisions in time of war. This article states that "in case of war the provisions of this convention shall not affect the freedom of action of any of the contracting states affected, whether as belligerents or as neutrals." In my judgment this will authorize any contracting state to disregard all of the legislative provisions of the convention in time of war. I do not think that it changes in the slightest the basic international air law rules as to airspace sovereignty, which, as I have sought to demonstrate earlier, existed long prior to the convention. The fact is that no presently existing convention can be relied on as a source of international air law applicable to war conditions This was recognized by the statement in International Law Situations of the Naval War College for 1938 (p. 38) that there were at that time "no binding rules of international law in regard to the conduct of hostilities in the air or in regard to neutral and belligerent rights in the air, * * * that most of the conceptions and many of the rules of maritime law will be carried over into rules for the air" and that "international agreement on the application of these rights is desperately needed." I must express the gravest doubt as to whether anything developed during World War II which demonstrates that the various maritime rules applicable to sea warfare have been in fact accepted by analogy as applicable to air warfare

You are doubtless familiar with the fact that after World War I an effort was made at the Washington Disarmament Conference in 1921–22 to agree on limitations of air armaments This was found inpractical. Arrangements were then made for a meeting of experts to be held to draft rules of air warfare which might be internationally adopted. A Commission of Jurists met at The Hague from December 1922 to February 1923 and produced what are now known as "The Hague Air Rules of 1923." They warrant careful study. But it must be understood that they never became effective. They may be considered as nothing more than the statement of a group of able international lawyers covering in part what they considered the law to be, and in part what they considered the law ought to be. Undoubtedly they have influenced government departments to some extent, but they can only be used, in determining what is the international law of the air, by testing their contents against accepted customary usages.

In 1939 the Harvard Research in International Law published its able and noteworthy study of "Rights and Duties of Neutral States in Naval and Aerial War." This included a draft convention covering a wide range of subjects, among them Aerial War In the notes to this draft convention will be found the following pertinent comment (p. 757): "It must be recognized that the development of aerial warfare and of commercial transport are of such relatively recent origin that it has produced no extensive practice of states sufficient to constitute rules of customary international law." The draft convention proposed by the Harvard Research covered parts of the subject-matter of The Hague rules of 1923, but did not include provisions as to the actual conduct of hostilities.

With this background and the resulting entire lack of certainty as to the rules of international air law in time of war, it is useful to examine a few specific situations within the limited time available.

Air bombardment.—During World War II Marshal of the RAF Sir Arthur Harris, who was Air Officer Commanding-in-Chief, Bomber Command, RAF, from February 1942 until the war ended, must have had responsibility for making grave decisions as to the conduct of air bombardment over enemy territory and over enemy-occupied territory. He must have had available adequate advice as to the existence of rules of international law covering the important military operations under his command. In publishing an account of these operations after the end of the war, he has given this unequivocal opinion: "International law can always be argued pro and con, but in this matter of the use of aircraft in war there is, it so happens, no international law at all." (Bomber Offensive, London, Collins, 1947, p. 177.) Such a statement coming from such an authoritative source cannot be disregarded.

The history of air bombardment during World War II is well known. Before the outbreak of the war and after both Germany and Japan had left the League of Nations, the Assembly of the League, considering the necessity for regulation of air bombardment, adopted the following resolution which has not had the consideration that it warrants:

"The Assembly * * *

"Recognizes the following principles as a necessary basis for any subsequent regulations;

"(1) The intentional bombing of civilian population is illegal.

"(2) Objectives aimed at from the air must be legitimate military objectives and must be identifiable.

"(3) Any attack on legitimate military objectives must be carried out in such a way that civilian populations in the neighbourhood are not bombed through negligence." (League of Nations Paper A 69, 1938, IX. September 28, 1938. Protection of Civilian Populations Against Air Bombardment.)

The difficulty with the entire problem of determining the international law of air bombardment arises from the lack of an accepted definition of what constitutes "a legitimate military objective" and what constitutes "civilian population." On the outbreak of World War II, President Roosevelt appealed to the belligerents urging that civilian populations be not bombarded from the air. Great Britain and France replied that they had instructed their commanders prohibiting bombardment from air or sea or by artillery on land "of any except strictly military objectives in the narrowest sense of the word." Hitler also indicated his agreement. But as the war progressed concepts were continually expanded and every nation originally engaged or which later became involved was faced with the practical necessities of war as it is now conducted, and found it necessary to consider as military objectives entire areas which contained industries, transportation facilities, or other parts of the complicated national machinery which is used behind the lines in modern warfare. Finally the climax of atomic bombing over Japan brought the world face to face with the question: Is there any international law to determine with exactness the definition of bombing objectives? At the last annual meeting of the American Society of International Law held in Washington, April 22–24, 1948, an Army officer present (speaking for himself and not for the Judge Advocate General's office to which he was attached) made "a plea for some constructive thought concerning the development of the international law of war." He insisted that "today there is absolutely no regulation concerning the use of aircraft in war," and that "if it is the practice of nations alone that makes international law, then we must accept the fact that the practice of both sides during this last war has made the use of aircraft for the indiscriminate bombardment of cities a part of international law." He urged that "we must attempt to draft and have accepted reciprocal rules of aerial warfare under which the next conflict can be fought," and that "to be effective, they must be rules which will grant reciprocal protection to both sides." With this position I agree. In the absence of the adoption of such a convention and faced with what appears to be lack of acceptance of clearly defined customary rules covering air bombardment, I am not clear as to whether there is any international law on the subject at the present time. Perhaps when we have had an opportunity to examine the records and findings of the various war crime courts and tribunals sitting in Germany and Japan, we may find that rules can be determined under "the general principles of law recognized by civilized nations" accepted as a source of international law to be applied by the World Court. But what those rules are I am unable to state today.

RELATIONS BETWEEN BELLIGERENTS AND NEUTRALS

One of the few groups of rules which can be considered as reasonably well established in international air law covers the right of neutrals to close their air boundaries in time of war and prohibits belligerents from engaging in acts of war over neutral territory. These rules arise from the basic considerations of airspace sovereignty already stated. In both World War I and World War II neutral states repeatedly forced down and interned belligerent military aircraft entering their airspace. During World War II the United States paid a very considerable indemnity to Switzerland on account of damage to property and loss of life of certain Swiss citizens occurring as the result of bombs being dropped by American aircraft on Swiss territory through error The Harvard Research has stated in its proposed articles 95, 96, and 97 of the draft convention, published in 1939, the following rules:

"*Article 95.*—A neutral state shall use the means at its disposal:

"(*a*) to prevent belligerent military aircraft from entering its territory; and

"(*b*) to compel them to alight if they have entered, and

"(*c*) to intern them after they have alighted, whether the landing be voluntary or forced, together with persons and property on board.

"*Article 96.*—The neutrality of a state is not violated by the passage through its territory of public nonmilitary or unarmed belligerent private aircraft.

"*Article 97.*—The requirements of neutrality do not in general necessitate the closing of neutral aerial frontiers against the passage of aircraft of other neutral states."

It will be noted that article 95 puts a positive duty on neutral states to use the means at their disposal to prohibit the entry of military aircraft and to compel them to alight. With this possible exception I believe that these rules state customary international law as evidenced by actual conduct of neutral and belligerent states during World War I and World War II. Certainly neutral states have the right to take the several actions mentioned in article 95, and I think that the evidence would be sufficient before an arbitral tribunal to sustain the actual duty to do so as outlined in the Harvard Research Article 95.

Whether it is possible to go further than this in stating the existence of definitely accepted rules applicable to relationships between belligerents and neutrals arising from air war is not at all clear. It has been repeatedly stated, for example, that the right of visit and search exists and that a belligerent aircraft may exercise this right of visit and search as against neutral aircraft. The Harvard Research Article 111 states that "belligerent aircraft may order such neutral aircraft to alight for visit and search in a locality reasonably safe and accessible" and that "refusal after warning to obey such orders to alight or to proceed to such a locality for examination, exposes an aircraft to the risk of being fired upon." Those of us who have had something to do with the operation of air transport services realize the practical difficulties in any such procedure. It is impossible to land an aircraft on the high seas with any degree of safety, even in the case of seaplanes, nor is it usually possible to divert an air transport with any degree of safety because of the closely calculated amount of fuel the aircraft carries to reach a scheduled destination. Actually I have been able to find no case in which this alleged right of visit and search has been exercised during either World War. Quite recently I had occasion to inquire about this matter. Dr J. M. Spaight, author of the authoritative Air Power and War Rights, advises me that he also knows of no instance of the exercise of the right of visit and search of aircraft by aircraft during World War II. In the absence of custom to establish the right, and to provide for the procedure of making it effective, and in the absence of any international convention or any court decisions on the subject, we are forced to the decision that the entire doctrine of visit and search of aircraft by aircraft depends on the perhaps justified views of qualified writers as to what international air law should be, leaving in doubt whether any such law on the subject actually exists.

The difficulties involved in the operation of air transport services by a neutral state to and from a belligerent state are evidenced by the problems presented to the Swedish airlines during the last war Traffic was inaugurated in February 1942 between Stockholm and Scotland after negotiations between the British and Swedish Governments. The German Government was not involved. Flights were operated at night over the North Sea when weather conditions were believed suitable—that is, when there were clouds and no moon. Aircraft were painted orange with Swedish markings but carried no lights. Radio communication was maintained only while the aircraft were over Swedish or British territory. One

night toward the end of August 1943 a plane returning from Scotland to Stockholm disappeared over the North Sea and traffic was suspended. It was believed that the plane was shot down by a German fighter plane, but no proof was available. A week after this accident traffic was resumed and toward the end of October a second plane crashed on the Swedish coast on its return trip from Scotland. On this occasion 1 crew member and 1 passenger survived and it was definitely proven that the plane had been shot down by a German fighter. The Swedish Government protested to German authorities who refused to pay any indemnity, contending that the German fighter had mistaken the aircraft for an Allied bomber. Traffic was again suspended. Thereafter, pursuant to negotiations by the Swedish authorities with both Allied and German authorities, the safe conduct traffic from Stockholm to Scotland via Norway was organized The planes carried full illumination, radio communication was maintained with German stations over Norway and British stations when approaching and leaving Scotland. After 12 trips, the British authorities canceled the arrangement. Later it was resumed on the original basis—that is, high altitude flights of unlighted planes at irregular intervals

This illustrates the lack of any accepted rules as to the maintenance of mutual commercial traffic between neutral and belligerent countries. It was my judgment during World War II, when I had some responsibility in the matter, and it is my judgment today that such neutral commercial aircraft engaging in transport to and from belligerent countries over routes which are in the part of the world where air hostilities may take place must accept risks of destruction in the absence of international convention to the contrary. From the belligerent point of view it must be realized that it is very difficult to distinguish between transport and bomber aircraft under bad weather conditions or during night flights Also, in the absence of some practical arrangement as to visit and search, a belligerent can prevent illicit air transport contraband operations only by shooting down neutral aircraft proceeding to and from belligerent territory in the war area. I again regret that I cannot accept the theory that the rules applicable to neutral shipping may by analogy be accepted at this time as part of international air law.

FUTURE USE OF GUIDED MISSILES ABOVE THE AIRSPACE

In closing this discussion I wish to present a problem to the Naval War College and request the assistance of the officers on duty here. Thus far I have not been able to produce a solution which satisfies me. Suppose that country A and C are at war. Their land territories do not touch at any point. A neutral country B occupies the surface territory between A and C. Let us then assume that country A starts bombarding country C with guided missiles passing through flight space over country B at an altitude which may be considered beyond the airspace and at a height where country B may find it impossible, with any devices in its possession or even in existence, to intercept such guided missiles or otherwise prevent their passage over its territory. Had the neutral rights of country B been affected?

Inherent in the answer to this problem is the basic difficulty of future international air law—to what height above the surface of the earth can the sovereignty of a state be extended. Able experts will contend that territory never exists beyond the ability of the state claiming such territory to make its laws effective and that sovereignty is the power to control. Other experts will contend that sovereignty is the right to control territory and that every state may be assumed to have sovereignty in space up to any height which any other state can reach with devices or missiles in its possession. In view of the fact that some of my scientific friends are convinced that rockets or other guided missiles may be propelled from the earth to the moon within a comparatively few years, the problem presents curious political and geographic difficulties.

High Altitude Flight and National Sovereignty

An address delivered before the Escuela Libre de Derecho, Mexico City, January 5, 1951, by John C. Cooper, Member Institute for Advanced Study (Princeton), Fellow American Academy of Arts and Sciences, Member Institute of the Aeronautical Sciences.

High altitude rocket flights have reopened an old question: How far upward in space does the territory of the state extend? This is a simple question to state, but a very difficult question to analyze, and perhaps even now an impossible question to answer. Nevertheless it must be considered.

If international relations are to be conducted in the future in anything approaching a normal manner, both the statesman and the jurist ought to know the extent to which a state has the acknowledged right to control all activity in the areas of space above its surface territory.

The territory of a state, geographically considered, is a three-dimensional region It includes an area on the surface of the earth, a sector of the earth below, and a sector of space above. Legally considered, the territory of a state may be defined as those regions in which the state is recognized by international law as having the right to exercise national sovereignty to the exclusion of all other states. As the distinguished jurist, Max Huber, said in his opinion in the island of Palmas arbitration between the United States of America and the Netherlands: "Sovereignty in the relations between states signifies independence. Independence in regard to a portion of the globe is the right to exercise therein to the exclusion of any other state the functions of a state * * * territorial sovereignty * * * involves the exclusive right to display the activities of a state" Among these territorial functions are included the right of a state to determine the extent to which it will control and police human activity within its territory

The legal concept that a state has territorial rights above the surface of the earth is far older than the discovery of the art of human flight. Rome did not hesitate to control the use of space whenever deemed necessary to protect public or private rights on the surface of the earth. The airspace over public highways and over sacred ground was kept open by law. The Roman emperors limited the height to which buildings could be erected. Private rights in space above the landowner's property on the surface were carefully protected. The Roman state made its laws as effective above the surface of the earth as it did on the surface. The great jurists of a much later era fully recognized the existence of state sovereignty in space. Pufendorf, for example, in the latter part of the 17th century remarked that "since man has been denied the ability to be in the air to the extent that he rest in it alone, and be separated from the earth, he has been unable to exercise sovereignty over the air except insofar as men standing upon the earth can reach it." To Pufendorf sovereignty in space was thus limited by the ability for effective control, and not otherwise.

With the discovery of the balloon in 1783 and the gradual development of the art of man-controlled flight culminating with the Wright brothers in 1903, man found a way "to be in the air to the extent that he rest in it alone," and the problem of the extent of state sovereignty upward became acute In analyzing this period it must always be remembered that neither statesmen nor lawyers conceived of the possibility of man-made flight through space beyond a region where there would be sufficient gaseous air to support a flight instrumentality of the general nature of a balloon or an airplane So in 1906 when Professor Westlake, at a meeting of the Institute of International Law, first put into concrete legal statement the doctrine of state airspace sovereignty, he added that there was no limit upward of such sovereignty. Discussing the necessity for state control in the air over its territory, he said "In the air the higher one ascends, the more damage the fall of objects will cause on the earth If there exists a limit as to the sovereignty of the state over the oceanic space, none exists for the sovereignty of the state over the airspace. The right of the subjacent state remains the same whatever may be the distance" It is perfectly obvious that Westlake assumed that the state had territorial rights in space as high as flight could exist, but at the same time he assumed that such flight must take place in what he termed "air space."

In 1911 the British Government prepared a draft statute to be entitled "Aerial Navigation Bill" which, in its preamble, recited that "the sovereignty and rightful jurisdiction of His Majesty extends, and has always extended, over the air superincumbent on all parts of His Majesty's dominions and the territorial waters adjacent thereto" Again it was assumed that if the state had sovereignty "over the air," it had the right to regulate all flight over its lands and waters.

Whether the term "air" or the term "airspace" was used, the basic idea was the same In the first great international legislative enactment of the fundamental principles of air law, the Paris Convention of 1919, article 1 stated that "The High Contracting Parties recognize that every Power has complete and exclusive sovereignty over the airspace above its territory" The convention then proceeded to the regulation of the use of "aircraft." In the annex to the convention, adopted shortly after it came into effect, aircraft were defined as comprising "all machines which can derive support in the atmosphere from reactions of the air."

The Paris Convention was a statement of long existing and fully recognized state sovereignty over a region called "airspace," but otherwise undefined, in which "aircraft" might operate But the Paris Convention is not to be construed as meaning that in international law states have territorial rights only in this airspace.

The airspace was accepted as part of state territory but no international determination was made as to the regions of space above. The same argument can probably be made with reference to the statutes of various states not parties to the Paris Convention which asserted sovereignty over the "airspace."

It might be argued that the Paris Convention, and certain other conventions, asserted state sovereignty in the earth's "atmosphere" beyond the regions where sufficient air exists to support the flight of aircraft as defined in the Paris Convention. Both the French and Italian versions of the Paris Convention use language in article 1 which literally translated into English means "atmospheric space" (French: espace atmospherique, Italian: spazio atmosferico). My own view has always been that these terms were intended to mean exactly what the English version meant, namely, the region of space where the "air" was present in, it must be assumed, sufficient quantities to support flight in the balloon or airplanes which were regulated by the convention. This argument is supported by the fact that the Madrid Convention of 1926, signed by Spain and various Latin American countries, referred in article 1 to sovereignty over "atmospheric space" (espacio atmosferico); while in the Habana Convention of 1928, signed by many of the same states, state sovereignty is recognized over the "airspace" (official Spanish text: "espacio aereo"). Although, as will be indicated hereafter, the earth's atmosphere from the purely scientific point of view extends much further above the surface of the earth than does the region in which "air" is present in sufficient quantities to maintain aircraft flight, it would seem that in the Paris, Madrid, and Habana Conventions the terms "airspace" and "atmospheric space" must be considered as synonymous, constituting legally a recognition that every state has territorial rights at least through these regions where sufficient gaseous air is found to support such flight.

This view is further borne out by the fact that the Chicago Convention of 1944, now in force, states in article 1 that "The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory." While the convention recites that French and Spanish texts were to be drawn up and opened for signature, this was apparently never done and the English text is still the only text which was officially signed. In the French translation of the convention which is ordinarily used, so I am advised, the English word "airspace" has been translated as "espace atmospherique," while in the Spanish translation distributed by the International Civil Aviation Organization, it has been translated as "espacio aereo."

It may, therefore, be said that international law now answers the question "How far upward in space does the territory of the State extend?" as follows: The territory of the state extends upward at least as far above the surface as to include a region which can be roughly defined as "airspace." An international law contains no presently accepted rule covering the question as to whether usable space above and beyond the "airspace" is or is not part of the territory of the state below.

It is at this point that high altitude rocket flights open unsolved legal and political problems. Just how high such flights have been made I do not know. But as long ago as the spring of 1949 it was disclosed in the public press that a 2-stage rocket had reached a height of at least 250 miles (400 kilometers) above the surface of the earth. This rocket passed far above the region which can, under any theory, be described as "airspace." The question is: Did it pass out of the territory of the state below when it left the airspace, and reenter that territory on returning; or was it at all times within the territory of the state below?

Before even suggesting an answer it is necessary to consider very briefly certain of the scientific views now generally held as to what constitutes the earth's atmosphere. This atmosphere is usually described as constituting four gaseous layers known as the troposphere, stratosphere, ionosphere, and exosphere. The troposphere is next the earth and the exosphere is the far distant region which gradually merges into outer space. The "airspace" is part of the lower atmosphere region. The troposphere extends upward about 54,000 feet (16,200 meters) at the equator, and 28,000 feet (8,400 meters) at the poles. It contains about three-fourths in weight of the gases composing the earth's atmosphere, and is characterized by continually decreasing temperatures with increase of altitude. The stratosphere extends from the upper level of the troposphere to about 60 or 70 miles (100 or 115 kilometers) above the earth's surface. It contains slightly less than one-fourth in weight of the earth's atmosphere, is characterized by constant temperature of about 67° F. (20° C.), then decreasing again to about −28° F. (−33° C.)

The ionosphere extends from the upper levels of the stratosphere to approximately 400 miles (640 kilometers) above the surface of the earth. It is said to be

characterized by the existence of what have been termed by some authors as "free electrical discharges." The temperature is estimated to increase steadily up to approximately 4,000° F. (2,200° C.).

The exosphere is the fringe area beyond the ionosphere in which the density of the gaseous atmosphere is even less, and is supposedly characterized by a uniform temperature of approximately 4,000° F. (2,200° C.).

It will be seen from the foregoing that the rocket which reached 250 miles (400 kilometers) above the surface of the earth was high up in the ionosphere. It was far past any region that could be termed "airspace." It is generally believed that above 60 miles beyond the earth's surface (approximately 100 kilometers) what we would term as a vacuum exists and that all of the aerodynamic features of flight which result in the lift of a normal type of aircraft have disappeared. It may be recalled in this connection that no airplane has ever been flown more than approximately 60,000 feet above the surface, sounding balloons have probably reached an altitude of 120,000 feet—both of these distances being far below the theoretical absolute outside limit of what might be termed "airspace."

Scientific investigation and progress in known rocket flights have therefore demonstrated that none of the international procedure set up in the Paris and Chicago Conventions applies in a very large percentage of the region to which these rockets have already reached. Future scientific progress makes the problem even more difficult. Rockets now in use are leaving the earth's surface at speeds of at least 5,000 miles per hour (8,000 kilometers). It has been estimated that if this speed can be increased to approximately 25,000 miles per hour (40,000 kilometers) at the top of the atmosphere, the power can then be shut off and the rocket would continue moving upward indefinitely. Certain scientists believe that these speeds can be attained with fuels now available, although at very great costs; others believe that new methods of propulsion may be required. One of my friends, a well-known astronomer, has indicated to me that the point at which such a rocket would leave the earth's area of attraction and pass under the predominance of the sun would be approximately 161,000 miles (256,000 kilometers) above the earth's surface. It is well to bear that figure in mind because if we hold to the old classic legal theory, as stated by Westlake, that a state must have sovereignty as high up into space as necessary to protect itself from "falling" bodies, then perhaps the state's territory is 161,000 miles in height.

But the problem is even more complicated than as just indicated. If a rocket or other man-controlled missile can take off from the earth with a speed of approximately 17,500 miles an hour (26,400 kilometers), it will be able to proceed upward for several hundred miles and could then be deflected off of its course so as to be aimed somewhat parallel to the surface of the earth, the power could be turned off, and the rocket would continue on a course around the earth as its momentum would approximately balance the earth's attraction. It would become an artificial satellite. From the international lawyer's point of view the question then arises: Does such an artificial satellite, flying several times per day around the earth and passing far above the surface territories of many states, enter and leave the territory of each of such states when immediately above their surface boundaries? If we accept the theory that the territory of the state extends as far upward into space, even though that space be a vacuum, as required to prevent the entry of manmade activity which may result in injury to persons and property on the surface of the state, then we must assume that such a satellite is violating the sovereignty of every state below which has not consented in advance to its passage There are scientists who believe that such a satellite can and will be constructed before many years have passed.

It is obvious that it is the duty of the trained jurist to suggest an answer to these problems It may be that a new international convention is required which will include some sort of agreed international limitation on the extent to which states will engage in high altitude flight somewhat similar to article 8 of the Chicago Convention which provides that no aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting state without special authorization by that state

In the absence of such a new convention, basic legal theories must be reexamined and the practical questions at issue must be understood

In the first place it is obvious that we must agree that there is an upper boundary in space to the territory of the subjacent state. Under no possible theory can it be said that a state can exercise sovereign rights in outer space beyond the region of

the earth's attraction. The arguments for state sovereignty in space have always gone back to the proposition that it is both the right and the duty of the state to protect itself and that on no other basis can such protection be considered adequate except that it have the right to control, as part of its territory, those regions above it which, if used by other states, may bring damage and loss to persons and property on the state below. Carrying this old rule to its extreme, the outer boundary of the state cannot be further than the point where the earth's attraction will govern the movement of an object in space so that such object will "fall" onto the earth.

On the other hand, this boundary cannot be lower than the upper limit of the airspace. The rule of international law—that the territory of the subjacent state includes at least the region above it known as airspace—need not be challenged. In other words, it would appear that the upper boundary of the state's territory lies at a point between the upper limit of the airspace and the upper limit of the earth's attraction. Somewhere in this vast intervening region the rights of the state below cease to exist as against other states.

Certain jurists have insisted that the territory of a state is limited by the ability of that state to make its law effective. This is a harsh rule when applied to sovereignty in space The richest and most powerful states now have means through high altitude rockets to control more or less effectively the airspace over their surface territories. But the weaker states have no such power. Can we be said to live in such a world where the physical power at any one time of any particular state determines its international right to consider the region above its surface territories as part of its national territory? I may say here that my own belief is and has always been that if the rule of effectiveness is to be applied to determine the limit of state territory in space, then the rule should be that every state, no matter how small or how weak, as a state or equal sovereignty with every other state, has and should be admitted to have territorial rights upward above its surface territories as high as the rights of every other state no matter how powerful

Perhaps the rule should be, in the absence of international agreement, that the territory of every state extends upward as far into space as it is physically and scientifically possible for any one state to control the regions of space directly above it. In considering the possibility of adopting such a rule as this as part of international law, its limitations must be understood The enormous distances involved must not be forgotten. Assuming that a state has acquired the use of a rocket that will leave the earth at the suggested speed of 25,000 miles per hour, it must be remembered that as it moves upward it will be continually slowed by the earth's pull. Therefore it would take a rocket traveling at even this tremendous velocity well over 6 hours to reach the theoretical distance of 161,000 miles beyond the earth's surface, at which point it enters into the area where the sun's attraction begins to predominate.

By the time that the rocket reached this far-distant region, for the purpose of policing or controlling its use by other states, the rocket may have itself passed through the theoretical territory of several states. It must be recalled that the earth itself is rotating. If this rocket is driven directly upward, it may not be directly over the territory of the state which fired it for a very long period. Any theoretical possibility of a state controlling far-distant regions in space is absolutely out of the question. I am convinced that we must abandon the theory that the state has the right to claim territory out into space as far as the earth's attraction extends, and that we must admit some such reasonable rules as I have suggested above—namely, that at any particular time the territory of each state extends upward into space as far as then scientific progress of any state in the international community permits such state to control space above it.

Frankly, this is not put forward as a final solution. It is realized that it leaves open such vital questions as to what extent of control is contemplated. It also leaves open the question of by what means an international determination will be made of the ability of the most powerful State to extend its control into outer space. I could argue at forceful and great length against the solution suggested. In its favor I can only say that it is worthy of consideration; that it provides the basis for a fairly livable world in which the weak State is not at the mercy of the strong. The mere suggestion of the rule, above all else, shows the gravity of the problem and the need for an answer.

For much of the data as to the scientific characteristics of the upper atmosphere, the author is greatly indebted to the article and chart entitled "The Earth's Atmosphere," by Howard E. Roberts, Aeronautical Engineering Review, vol. 8, October 1949, pp. 18–31.

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Legal Problems of Upper Space

By John Cobb Cooper [1]

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Today neither lawyers not governments are prepared to state the legal flight rules applicable to presently operating rockets and planned satellites. For the second time in the present century science and engineers have far outstripped the law. Such delay may be normal where legal rules must depend on known and accepted factual situations, but the gap between technological and legal progress must never be permitted to become too wide.

The present problem confronting us is this: Flight instrumentalities, such as rockets, satellites, and other spacecraft do not fall within existing national or international regulatory provisions. Nor is there any agreement as to what, if any, national or international regulation is applicable to space above the atmosphere where such rockets and satellites will normally be used. This existing legal hiatus can lead to grave international misunderstanding if permitted to continue too long

Flight technology first outdistanced the law in the early years of the present century when it became necessary to determine whether aircraft and balloons were vehicles like automobiles or whether they had nationality like ships; also, whether the atmosphere space in which they operated was or was not part of the territory of the subjacent state The manner in which these questions were settled reveals the extent of the dangerous legal hiatus which now confronts us.

Flight became a factor in international affairs when it could be controlled by man. The airship flights of von Zeppelin between 1900 and 1902, and the airplane flight of the Wright brothers in 1903, were the real beginning. But governments were slow to fix the legal rules, and jurists were not in agreement. In 1906, in the much-discussed debates in the Institute of International Law, Fauchille urged freedom of flight and Westlake insisted upon national airspace sovereignty. But the importance of this discussion has, in my judgment, been exaggerated. It had little, if any, influence on the subsequent activities of states. Fauchille ignored the fact that distinguished jurists had long insisted that territory must be three dimensional. Westlake, while supporting sovereignty, appeared to believe that such sovereignty should be subject to an international right of innocent passage through the airspace, although no state ever accepted this dictum in practice

Governments did not become really concerned until France, in 1908 and 1909, took alarm at the number of German balloons which were drifting into France, many apparently manned by military personnel, and called the celebrated 1910 International Air Navigation Conference. This met in Paris to consider the possible regulations of international flight. The United States was not invited, as it was considered too far away to be affected. On more than one occasion I have stated my view that the proceedings of this 1910 Paris Conference, with its almost completed draft convention, indicated general agreement that each state had full sovereignty in then usable space over its national lands and waters, that no general right of international transit existed for aircraft of other states in the absence of international convention, and that the only practical legal method of regulating international flight was by agreement which would provide for the grant of privileges of flight through such national space.

By legislative acts and diplomatic conduct in the intervening years between the 1910 Conference and the outbreak of World War I, Europe indicated acceptance of these principles Events at the outbreak of World War I and during that war, as well as the preparation and signature of the Paris Convention of 1919, gave further evidence of the validity of the principle of absolute sovereignty of the subjacent state over the "airspace," and also of the fact that aircraft have nationality.

The Paris 1919 Convention was signed and ratified in French and Italian as well as in English The words "air space" appear in the French version as "espace atmosphérique" and in the Italian as "spazio atmosferico." It seems apparent from this that the words "air space" in the English version meant, without question, "atmospheric space."

In many articles of the convention, the flight instrumentalities to be regulated are described as "aircraft," and their nationality is recognized. Under the system

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of the Paris Convention, its subsequently adopted annexes became part of the convention itself In these annexes an "aircraft" is defined as follows: "The word 'aircraft' shall comprise all machines which can derive support in the atmosphere from reactions of the air." In annex A various classes of "aircraft" included balloons, airships, landplanes, seaplanes, and helicopters

Taking together the assertion of state sovereignty in article I, with this definition of "aircraft," it may be said that the Paris Convention declared that each state was sovereign in those areas of space where sufficient gaseous atmosphere existed to lift and support balloons, airships, and airplanes, as well as other types of flight instrumentalities which could "derive support in the atmosphere from reactions of the air " Man had not yet conceived the possibility of any other type of flight instrumentality, nor had he had occasion to regulate areas of space other than those used by "aircraft."

In 1926, by the adoption of the Air Commerce Act, the United States (which signed but did not ratify the Paris Convention) declared itself to possess complete and exclusive national sovereignty in the airspace over the United States, and defined aircraft to mean "any contrivance now known or hereafter invented, used or designed for navigation or flight in the air " These rules were carried forward in the Civil Aeronautics Act of 1938, and are still part of our law. It is conceivable that this definition of aircraft is broader than the Paris definition, as it seems to include flight instrumentalities used for flight in the air even though not supported thereby.

The Chicago Convention of 1944, to which most of the states engaged in international aviation are parties, except the U. S. S. R., restated in article I the provisions of the Paris Convention as to airspace sovereignty in this manner: "The contracting states recognize that every state has complete and exclusive sovereignty of the airspace above its territory." Again, as in the Paris Convention, this is a statement of customary international law and not an exchange of privileges between the states concerned. Also, the Chicago Convention deals with the regulation of "aircraft" which are given the attribute of nationality. But neither "airspace" nor "aircraft" is defined.

Under the Chicago Convention the technical standards, called annexes, do not become parts of the convention. They are prepared by the International Civil Aviation Organization, and are then submitted to the member states for acceptance. Any state finding it impractical to comply in all respects with such standards must so advise the International Civil Aviation Organization.

During the Chicago Conference, the United States submitted suggestions for future annexes, including the definition of aircraft similar to that in the Air Commerce Act of 1926 as stated above. But the Chicago Conference inserted in the tentative annexes the definition of aircraft as it had already existed in its narrower form in the Paris Convention annex. Subsequently, the International Civil Aviation Organization, when formally adopting the present annex 7 dealing with aircraft nationality and registration marks, defined aircraft as "any machine that can derive support in the atmosphere from the reactions of the air." This is almost exactly the Paris definition adopted many years earlier. In the same annex, the term "aircraft" is stated to include balloons, airships, airplanes, and helicopters, and other similar instrumentalities requiring support in the atmosphere from reactions of the air in order to maintain flight.

When this annex was submitted to the member states of the International Civil Aviation Organization, no objection was apparently raised by the United States or any other member state, and it may therefore be that this is the definition which the United States must apply in international use rather than its own definition. This, however, is a problem which has not yet arisen, but which may become acute if a type of flight instrumentality is launched by the United States, which is covered by our own definition of "aircraft," but is not included in the international definition adopted pursuant to the Chicago Convention.

From the foregoing the following appears to be the present legal situation:

(*a*) Both the Paris and Chicago conventions have dealt only with those flight instrumentalities which derive support in the atmosphere from reactions of the air, such as the balloon or airplane, and have not dealt with such instrumentalities as rockets, satellites, and other space craft which are designed to move through space without atmospheric support.

(*b*) The Chicago Convention contains no definition of "airspace" but it may well be argued that, as it was adapted from the Paris Convention, it deals with no areas of space other than those parts of the atmosphere where the gaseous air is sufficiently dense to support balloons and airplanes. The highest flight by any un-

manned balloon up to the present time is 140,000 feet, by a manned balloon 72,395 feet, and the highest airplane flight is 90,000 feet.

(c) Nothing in the Chicago Convention precludes the possibility of state sovereignty being extended by international agreement, or by unilateral force, above the areas in which the airplane and balloon can be used, but there is certainly no basis on which any customary international law can as yet be considered applicable to such higher areas.

(d) Airspace over the high seas is now free for use by all.

The present technical situation is also of major importance. Basing my information solely upon public disclosure in the press and the current literature, I would invite your attention to the following:

(a) Rockets of the so-called V–2 type, as used in the German attacks on London, are understood to have been driven to a height of about 114 miles. An American rocket, which consisted of a V–2 plus an additional rocket stage, has been publicly stated to have reached an altitude of about 250 miles.

(b) It now appears that there is an area between the highest possible balloon flight—let us say, 30 miles above the surface of the earth—and 200 to 300 miles above the surface of the earth, in which continuous or extended satellite flights may be extremely difficult due to the presence of sufficient atmosphere to create serious "drag" or heating.

(c) In other words, it is now suggested that the future satellite flight will be most practical for long distances only if conducted not less than 200 or 300 miles above the surface of the earth.

In July, 1955, the United States announced that it would support a series of satellite flights as part of the wide scientific investigation of the 1957–58 International Geophysical Year. Some of the details of the proposed flights have now been disclosed. It is planned to drive a three-stage rocket at least 200 miles above the surface of the earth, carrying in its nose the "satellite," which will be a round object about the size of a basketball. The directions of the various stages of the rocket will be so changed that when the satellite is discharged and starts on its free orbit it should be approximately parallel to the surface of the earth. Based on the much-discussed principle that if the speed of the rocket at that point is sufficient to counterbalance the attraction of the earth, the satellite should continue on an orbit around the earth for several days or even for several weeks, the time being dependent, among other things, on the amount of atmospheric "drag." The satellite will carry in its small bulk an amazing collection of instruments for obtaining information deemed by the scientists to be of the greatest possible future value. The International Geophysical Year, of which this satellite program is part, is directed by committees made up of scientists of many different nations. But the satellite itself will be launched by the United States Government.

Two authorities have already dealt with the legal problems of this flight. Mr. Andrew G. Haley, general counsel of the American Rocket Society, presented a paper at the annual meeting of that society in November, 1955, in which he seemed to suggest that the areas of space above the atmosphere to be used by the satellite might be subject to some sovereign control of the subjacent states, but that failure of any state to object to the International Geophysical Year satellite program at the time of its announcement was all that was required in order to make the completion of the program possible. He added that "The scientists have benefited mankind as a whole in a field where the lawyers might well have failed."

Quite a different thesis has been put forward by Mr. C. Wilfred Jenks, an associate of the Institute of International Law.[2] In his article Mr. Jenks noted the announcement by the White House of a satellite program "to circle the earth in 90 minutes at a height of 300 miles." His legal position is, apparently, that space beyond the atmosphere of the earth is and must always be incapable of appropriation by the projection into such space of any particular sovereignty based on a fraction of the earth's surface. He argues that the acceptance of such complete international freedom in these areas of space is required by astronomical and physical facts, and he contends that the only activities "within the atmosphere of the earth would appear to be susceptible of the degree of control similar in general nature to that which can be exercised in territorial waters or over a wider maritime frontier belt." It would therefore appear that Mr. Jenks denies the existence or possibility of national sovereignty in areas of space beyond the atmosphere—say from 300 miles above the earth's surface upward. He continues:

[2] "International Law and Activities in Space," 5 International and Comparative Law Quarterly 99–114 (January 1956).

"It would seem important to accept this principle fully from the earliest stages of the exploitation and exploration of space, and it is of interest that the United States plan for launching space satellites appears to be based upon it. There is no indication in the United States plan that it is proposed to negotiate passage agreements with the subjacent sovereignties. Moreover, such rights cannot be claimed under the International Civil Aviation Convention, since even assuming the Convention to be applicable beyond the atmosphere and disregarding the fact that certain states, including the U. S. S. R, are not parties to it, the Convention provides that pilotless aircraft will not be flown over the territory of contracting states without special authorization."

The statements by Mr. Haley and Mr. Jenks point up the importance of the problem to be considered—namely, What is the legal status of the space beyond the atmosphere where rockets and satellites can be operated without undue atmospheric interference?

A subsidiary question involves the status of the intermediate area between the upper level of the atmosphere used by aircraft and the lowest height at which a rocket or satellite may freely be operated. I am not sure that we yet have the scientific data necessary to determine the extent to which rockets or satellites may safely use this intermediate area. At least I do not feel that sufficient data is publicly available.

Five years ago, in what may have been the earliest present-day discussion of the question of the legal status of space at high altitudes,[3] I suggested that the time had come when "we must agree that there is an upper boundary in space to the territory of the subjacent state," and I said:

"Certain jurists have insisted that the territory of a state is limited by the ability of that state to make its law effective. This is a harsh rule when applied to sovereignty in space. The richest and most powerful states now have means through high altitude rockets to control more or less effectively the "airspace" over their surface territories. But the weaker states have no such power. Can we be said to live in such a world where the physical power at any one time of any particular state determines its international right to consider the region above its surface territories as part of its national territory? I may say here that my own belief is and has always been that if the rule of effectiveness is to be applied to determine the limit of state territory in space, then the rule should be that every state, no matter how small or how weak, as a state of equal sovereignty with every other state, has and should be admitted to have territorial rights upward above its surface territories as high as the rights of every other state no matter how powerful."

At the same time I indicated that this left open such questions as the extent of contemplated control, and the means by which an international determination could be made of the ability of the most powerful state to extend its control into outer space. Long and careful consideration during the past five years has convinced me of the existence of almost insuperable difficulties in applying the rule which I then suggested. The only practical way to solve the questions as to the legal status of areas above those covered by a strict construction of article I of the Chicago Convention will be the adoption of some form of international agreement.

Such a new convention might include these solutions:

(*a*) Reaffirm article I of the Chicago Convention, giving the subjacent state full sovereignty in the areas of atmospheric space above it, up to the height where "aircraft" as now defined, may be operated, such areas to be designated "territorial space."

(*b*) Extend the sovereignty of the subjacent state upward to 300 miles above the earth's surface, designating this second area as "contiguous space," and provide for a right of transit through this zone for all non-military flight instrumentalities when ascending or descending.

(*c*) Accept the principle that all space above "contiguous space" is free for the passage of all instrumentalities.

These solutions would aid future peaceful use of rockets and satellites and would seem to provide reasonable security for the subjacent state. At the same time, the territory of the state would be extended upward even beyond the areas in which it might make its normal laws effective. For I venture to suggest that, due in part to the physical problems involved, in part to the enormous speeds of the flight instrumentalities concerned, as well as many other difficulties, it will

[3] "High Altitude Flight and National Sovereignty," 4 International and Comparative Law Quarterly 411-418 (1951).

be most unlikely that any state can make its normal day-by-day laws effective very high in space I do not deny the possibility that with modern weapons, such as guided missiles, a state may exercise military command quite high into space, provided it is certain that its activities are within the areas which are really above its own territory But I must differentiate between such military control as may be involved in shooting down an intruder, and the normal civil control that a state must have day by day to enforce in its territory the peacetime laws under which men live together.

These ideas are put forward only as suggestions. The main problem is that an agreement would be most useful regarding the status of space above the "territorial space" covered by the Chicago Convention As a word of caution, I would again suggest that we may not yet have the physical and scientific information needed to reach immediately the soundest decisions. The data being collected by the International Geophysical Year program will help tremendously. But it would be unfortunate if international rules of future high altitude flight control were adopted, and if it were then found that they were based on incorrect theories as to the physical characteristics and usefulness of various areas in the upper atmosphere and beyond

At this point I wish to express my appreciation to my one-time colleague at the Institute of International Air Law, Mr. R S S. Allen of London, who under my direction has done a great deal of research in certain of the problems here discussed. It was Mr. Allen who first suggested to me the advisability of three zones, although the zones which are now indicated are not exactly those he had in mind.

Certain additional questions require consideration. If a new convention is not adopted, should the International Civil Aviation Organization amend its annexes so as to expand its definition of "aircraft" to include instrumentalities which, like rockets and satellites, were not contemplated at Chicago? It must be recalled that article XII of the Chicago Convention already gives to the International Civil Aviation Organization the power to adopt flight rules as to the operation of aircraft when over the high seas. This article would have greater significance if "aircraft" included rockets and satellites when flying above the high seas.

Another problem to be dealt with is the difficult question of nationality. The whole theory of nationality, as derived from the law of the sea, is based on the concept that when a state gives to a ship the right to use its flag, such state assumes certain international responsibilities for the good conduct of that ship on the high seas and in foreign ports and at the same time acts as the protector of the ship to enforce its international rights. Under the Chicago Convention, aircraft are given the same characteristic of nationality. In addition, article VIII deals with aircraft "capable of being flown without a pilot," and it would seem that such pilotless aircraft also have nationality. While the application of the rule of nationality to rockets and satellites may be difficult, nevertheless if upper space is to be free like the high seas, then certainly a state must be prepared to be responsible for the international good conduct of its rockets and satellites; otherwise chaos might result. Nationality must be considered when these new types of flight instrumentalities are brought within the sphere of international regulation.

Assuming that decisions are made as to the legal status of the various usable zones in space and as to the legal status of flight instrumentalities not now included in the international definition of "aircraft," a further problem must be solved: Some jurists appear to doubt if the International Civil Aviation Organization, set up under the Chicago convention, should be designated as the international body to regulate and control the use of all areas of space for nonmilitary purposes, and indicate that the problems of future rocket and satellite flight in upper space are so interlinked with other international problems that some new world organization must be created to deal with the new questions involved. I am not yet convinced of the need for a new organization.

In summary, the purpose of this paper is to place before you certain basic problems. The solutions which I have tentatively suggested may not be accepted, but I do urge that as soon as the physical characteristics of the upper atmosphere and space beyond are sufficiently known to warrant the adoption of acceptable rules, then an international conference be held to amend the Chicago convention, or to adopt a new convention, so that all areas of space now usable, or which may become usable within a reasonable time, may be considered, and agreement reached as to the status of each. Agreement must also be reached as to how, and by whom, and under what circumstances, new instrumentalities of flight, such as rockets and satellites, will be regulated. It is certainly the duty of international lawyers to give these matters their earnest attention so as to be in position, when the time comes, to aid in reaching an international accord.

[Not to be released before 9:30 a. m., February 22, 1958]

MISSILES AND SATELLITES: LAW AND POLICY

Address by John Cobb Cooper[1] at regional meeting of the American Bar Association, held in Atlanta, Ga., on February 22, 1958

The conquest of space is moving rapidly forward, paced by science and spurred on by national rivalries. But the law has lagged dangerously behind.

V-1 and V-2 missiles appeared toward the end of World War II, but few appreciated their significance as the beginning of a new era

The airpower of the United States was then unequalled. But it is now apparent that the Soviets had already begun careful preparation for the future. Twelve years ago in 1946 the information bulletin issued by the Soviet Embassy in Washington, on occasion of the Russian aviation day, said:

"Development of the industry is proceeding in accordance with the aim that Soviet aircraft must fly higher, faster, and further than any others, and that the Soviet plane industry must lead that of the world."

That aim still stands. Airpower is, in the last analysis, the ability of a nation to fly. Gen. William Mitchell said in 1925 that "Airpower may be defined as the ability to do something in the air." Gen. H. H. Arnold, as commanding general of the United States Army Air Forces, summed up the situation in his final report at the end of the last war as follows:

"Airpower is not composed alone of the warmaking components of aviation. It is the total aviation activity, civilian and military, commercial and private, potential as well as existing."

This I believe the Soviets have always understood.

In 1955 the United States announced its plan to launch manmade satellites in aid of the International Geophysical Year. The Soviet Government made a similar announcement, doubtless still mindful of the fundamentals of airpower and of the policy that "Soviet aircraft must fly higher, faster, and further than any others." The manmade satellite and rockets required for its launching, whether designed for scientific or military use, are products and instruments of airpower.

No concealment was made of the ultimate objective. In the issue of Pravda published June 1, 1957, the president of the Russian Academy of Sciences, writing on the subject, "The Problem of Creating an Artificial Earth Satellite," said:

"As the result of many years of work by Soviet scientists and engineers to the present time, rockets and all necessary equipment and apparatus have been created by means of which the problem of an artificial earth satellite for scientific research purposes can be solved."

During the same month the head of the U. S. S. R. International Geophysical Year committee advised the headquarters of that organization in Brussels that "in the Soviet Union during the International Geophysical Year the first launching of a manmade satellite for scientific purposes will be made." On October 4, 1957, this publicly stated program culminated in the successful launching of Sputnik I. The technical and scientific methods employed have not been disclosed, but the objective was never concealed.

A month later the second Russian satellite was launched and eventually our American Explorer. Today Sputnik II and Explorer are circling the earth at the tremendous speed of 18,000 miles per hour. These successful satellite launchings prove beyond question the development of rockets of enormous power and thrust capable also of launching missiles with nuclear warheads.

The Soviet Government claims to have developed an intercontinental missile with a range of 5,000 miles. The Soviet land mass includes about one-sixth of the land surface of the earth. From selected launching sites in that vast area missiles with a 5,000 mile range can reach almost any point on 4 continents: North America, including Alaska, Canada, the United States, and most of Mexico; all of Europe; all of continental Asia, together with Japan, Ceylon, and Indonesia; all of Africa south to Johannesburg.

The development of airpower and scientific progress have loosed forces which, uncontrolled, may well destroy the civilization which has created them. These forces are today beyond the rule of law. This should be of equal concern to the lawyers, as well as to the military experts and policymakers.

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PRESENT STATUS OF THE LAW

Certain rules must be considered in determining the relationship of the law to the flight of guided missiles and satellites. The first of these deals with the nature of such instrumentalities of flight The regulations adopted by the International Civil Aviation Organization for the control of international flight apply to aircraft and to aircraft only. These are defined as including "all machines which can derive support in the atmosphere from reactions of the air." Satellites and rockets do not depend for their support upon the presence of gaseous air. Nor do rocket motors require the presence of gaseous air as a source of the oxygen needed for combustion; rocket fuels are self-contained. It is true that in 1926 the United States in the Air Commerce Act defined aircraft to mean "any contrivance now known or hereafter invented, used, or designed for navigation or flight in the air." In my judgment, the United States cannot insist upon this somewhat broader definition of aircraft when dealing with international flight because it has accepted without objection the definition proposed by the International Civil Aviation Organization, and now included in one of the applicable annexes to the Chicago convention of 1944, to which the United States is a party, and which is the only widely accepted convention regulating international flight

The International Civil Aviation Organization has power to submit amendments to this annex, and might broaden its definition to include rockets, missiles, and satellites But this would not cure the basic difficulty. The Soviet Union and a few other countries are not parties to the Chicago convention, and therefore not bound by the rules and regulations of the International Civil Aviation Organization. I submit to you, therefore, that there are no presently enforcible international flight regulations covering the use of rockets, guided missiles, satellites, or eventual spaceships, while in flight beyond the territory of a sovereign state.

The second rule to be considered is the extent to which a state may control flight into, through, or above its own territory.

Under presently accepted international law, so I insist, every sovereign state has complete and absolute right of control of all transport activities in its territory and has the sole right to determine what foreign instrumentalities may be permitted to enter. It should be of interest to American lawyers to recall that the United States contributed much toward the clarification and acceptance of this rule. I have in mind particularly the cogent opinion of Chief Justice Marshall in the celebrated case of the *Schooner Exchange*, in which he said in 1812 (7 Cranch 116) that all exceptions "to the full and complete power of a nation within its own territory must be traced to the consent of the nation itself." I also have in mind the vigorous rejection by Monroe as Secretary of State of the protest made by the Spanish Minister when the Spanish Government sought to challenge the right of the United States to decide what ships under which flags might be permitted to enter our ports.

The real problem therefore that arises is: What do we mean by the territory of a state? It is now accepted doctrine that such territory is in fact three dimensional, including the lands, territorial waters within its surface recognized boundaries, and also the airspace above. In the first great international aviation convention, the Paris convention of 1919, which was signed although not ratified by the United States, article I provided that "every power has complete and exclusive sovereignty over the airspace above its territory."

Kelsen, in his classic work, General Theory of Law and State, discussing this article, said:

"The territory of a state is usually considered as a definite portion of the earth's surface. This idea is incorrect. The territory of the state, as the territorial sphere of validity of the national legal order, is not a plane, but a space of three dimensions * * * The space above and below (the surface) belongs legally to the state as far as its coercive power * * * extends."

Kelsen carefully limited the geographical extent upward of the territorial area of a state in space by insisting that the "airspace * * * which is beyond the effective control of the territorial state has the character of no state's land." But he added that the territorial state below had the exclusive international right to extend its jurisdiction upward as its technical means progressed.

Under the Air Commerce Act of 1926, the subsequent Civil Aeronautics Act still in force, and through ratification of the Chicago Convention of 1944, the United States has asserted its complete and exclusive sovereignty in the airspace above it. In other words, that such airspace is part of its territory.

The U. S. S. R. is not a party to the Chicago Convention, but for years it has by statute and otherwise also asserted its sovereignty in the airspace over its

lands and waters, and has vigorously enforced its right as territorial sovereign in such area to determine what, if any, foreign instrumentalities may be permitted to enter its airspace. In fact, this is the asserted position of almost every state in the international community, and certainly of every state that is a member of the United Nations.

The present chaotic condition of the law applicable to the flight of rockets, guided missiles, and satellites stems from the fact that neither in the Paris Convention of 1919, nor in the present Chicago Convention of 1944, nor in national legislation is there any definition of what is meant by "airspace."

Some years ago I suggested the term "flight space" for future international treaties to include so much of universal space above the surface of the earth as is now used or hereafter to be used as the area in which flight takes place, defining "flight" as movement through space of man-operated and man-controlled devices or instrumentalities such as balloons, dirigibles, airplanes, rockets, guided missiles or spaceships. Satellites would, of course, be included. This term "flight space" was recently revived by Dr. Cheng of the University of London, who said that flight space should consist of two parts: namely, airspace and outer space. This emphasizes our present dilemma: Where is the boundary between airspace as part of the national territory of the state below and outer space beyond?

I am convinced, as I have said previously on several occasions, that the term "airspace" in the Paris Convention of 1919 and in the Chicago Convention of 1944 was there meant to include only those parts of the atmosphere above the surface of the earth where gaseous air is sufficiently dense to provide aerodynamic lift for balloons and airplanes, the only types of aircraft in existence when those conventions were drafted. However, I have also said and wish to repeat that nothing in the Chicago Convention precludes the possibility of state sovereignty being extended by international agreement or unfortunately by unilateral force above the area in which such airplanes and balloons can be used, but there is certainly no basis on which any customary international law can as yet be considered applicable to such higher areas.

The problem has been further complicated very recently by an official announcement of the planned construction of a new American aircraft to be known as X–15. In the statement of the Hon James H Douglas, Secretary of the Air Force, before the Preparedness Investigating Subcommittee of the Senate Armed Services Committee, he said that the Air Force had been engaged in explorations of outer space and associated technical fields since the end of World War II. Noting that with aircraft X–1 man in 1947 first exceeded the speed of sound, and with X–2 first soared to altitudes of more than 20 miles, he then said:

"The current model of these aircraft under development is the X–15, which should permit man to fly at speeds greater than 1 mile each second and at altitudes above 100 miles. I recount this continuity of development efforts to illustrate the fact that there is no easily recognized boundary between the atmosphere and space The one merges into the other and we must learn to use both. The techniques and actual developments involved in the X–15 are one path to man's flight into space. The X–15 is a step toward a manned satellite."

So it seems that we are now constructing a flight instrumentality which will move through our territorial airspace in which we have the sole right to control flight, and then into areas beyond. Sputnik I and Sputnik II in their orbits approached within approximately 125 miles of the earth's surface. X–15 will move into the same areas.

We have no rule of law, national or international, to govern such flights beyond the atmosphere. Unless this situation be rectified, chaos is before us.

POLICY: NATIONAL AND INTERNATIONAL

The United States and the other nations in the international community must, without delay, answer these questions: Where is the upper boundary of the territorial airspace? What control shall be agreed upon as to flight in areas beyond? These are policy decisions. If taken unilaterally by any powerful state, grave conflict may result. The international community must act, and act promptly.

In my judgment, international conduct during the past 3 years is leading to the acceptance of the rule that those areas of space which may be termed outer space, where there is not atmosphere of sufficient density to create drag or otherwise affect flight, is beyond the sovereignty of any state. Such course of dealing includes, among other things, the following:

(1) The announcement by the United States and the U. S. S. R. of their respective programs for satellite flight in aid of the International Geophysical Year. So far as I am advised no state above whose territory such flights would take

place made any protest, and many states participated in the scientific committees dealing with the subject.

(2) Neither the United States nor the U. S. S. R., to my knowledge, asked formal consent from all the states over which such flights would proceed—although such consent would undoubtedly have been requested and required by international law had such flights been planned to take place in the "airspace."

(3) President Eisenhower in his January 1957 state of the Union Message stated that the United States was willing to enter into any reliable agreements which would mutually control outer space missile and satellite development, followed by disarmament proposals including an inspection system to assure that outer space would be devoted exclusively for peaceful and scientific purposes.

(4) Sputnik I, Sputnik II and Explorer were launched in their several orbits. They probably passed over the surface territory of every important state in the international community. I have been able to find no record that any state has protested that such flights have violated their territorial rights.

(5) First the Political Committee and then the Assembly of the United Nations, in the latter part of 1957, adopted a resolution that the Disarmament Subcommittee should give priority to reaching a disarmament agreement to include an inspection system designed to ensure that the sending of objects through outer space would be exclusively for peaceful and scientific purposes.

(6) In President Eisenhower's historic January 12 letter to Marshal Bulganin, he stated that he was making a proposal to solve what he considered to be "the most important problem that faces the world today," and then proposed that "we agree that outer space should be used only for peaceful purposes."

It seems to me that all of these things lead to but one conclusion: Namely, that the great areas of space beyond the atmosphere are being dealt with on the basis that they are beyond the territorial sphere of any single sovereign state. This should be confirmed by a formal international agreement, vesting in some international body the power to control and regulate flight in the areas in question.

My major difficulty is that immediately above the areas of admitted national sovereignty—that is, where sufficient gaseous atmosphere exists to provide aerodynamic support for aircraft and balloons—lies an area in which there appears to be sufficient gaseous atmosphere to affect flight. For example, the data furnished me by the Mullard Radio Astronomy Observatory in Cambridge, England, indicate that the minimum height of the original orbits of both Sputnik I and Sputnik II was only about 125 miles above the earth's surface, and that the orbit time of both sputniks decreased initially each day—indicating a decrease in the maximum height of the satellite flight daily. In other words, both of these satellites came sufficiently close to the earth to be subject to drag. I do not think that we yet have sufficient scientific information from the Geophysical Year to determine whether all of this drag or a substantial part of it was caused by the presence of gaseous atmosphere. However, if, as now seems to be the case, it is found that the satellite Explorer, whose minimum orbit height above the surface of the earth is somewhat beyond 200 miles, is not materially changing its flight time daily, then it might well be argued that somewhere in the area between 125 and 225 miles above the earth's surface the atmosphere ceases to have any appreciable effect on free satellite flight.

Before Sputnik I was launched, in fact in 1956, I suggested to the American Society of International Law the basis for a policy decision to be incorporated in a new international agreement as follows:

Reaffirm article I of the Chicago Convention, giving the subjacent state full sovereignty in the areas of atmospheric space above it, up to the height where aircraft, as now defined, may be operated; such areas to be designated "territorial space";

Extend the sovereignty of the subjacent state upward to 300 miles above the earth's surface, designating this second area as "contiguous space" and provide for a right of transit through this zone for all nonmilitary flight instrumentalities, when ascending or descending;

Accept the principle that all space above "contiguous space" is free for passage of all instrumentalities.

This suggestion was made in the light of then available scientific data which appeared to indicate that future satellite flight would be practical only if conducted not less than 200 or 300 miles above the surface of the earth. At the same time I stated that the main problem was that agreement should be reached regarding the status of space above the territorial space covered by the Chicago Convention, but that we may not yet have the physical and scientific information needed to

reach immediately the soundest decisions and that it would be unfortunate if international rules of future high altitude flight control were adopted based on incorrect theories as to the physical characteristics and usefulness of various areas in the upper atmosphere and beyond.

As recently as February 8, 1958, Rt. Hon. John G. Diefenbaker, Prime Minister of Canada, in an address before the midwinter meeting of the Canadian Bar Association, when urging that an international agency to control outer space should be named by the United Nations, repeated the suggestion as to three zones which I had made in 1956—without, of course, in any way committing himself or his government as to a final decision.

As to the extent of the territorial airspace, it has been suggested recently—particularly by Mr. A G. Haley, general counsel of the American Rocket Society and president of the International Astronautical Federation—that territorial airspace should be considered as extending upward to a point where there is not sufficient gaseous atmosphere left to contribute in any way toward aerodynamic lift. This point is approximately 50 miles above the surface of the earth—about twice as far upward as any aircraft has yet penetrated. This is again a matter which might well be settled by future international agreement

Sir Leslie Munro, the Ambassador from New Zealand to the United States, and now President of the General Assembly of the United Nations, in an address before the New Jersey State Bar Association on November 22, 1957, said: "As to the actual convening of states on problems raised by recent and imminent ventures into outer space, I believe that the United Nations is the proper forum for necessary discussion " With this view I fully concur.

On January 31, 1958, Hon. Kenneth B. Keating, Member of Congress from New York, speaking before the annual meeting of the New York State Bar Association, made the following able proposal:

"I urge that the United States take the lead in formalizing international recognition of freedom of outer space. Specifically, I recommend the following three point program for international action:

"First, an immediate declaration that outer space is not subject to appropriation by any nation. This 'Freedom of Outer Space' declaration could pave the way for peaceful cooperation among all nations to best utilize the treasures of these unexplored regions.

"Second, I propose an international agreement barring the use of outer space for any military purpose.

"Third, an existing international agency should be adopted or a new one formed for the joint exploration of outer space

"Such a program is urgently needed to promote a universal dedication to the development of outer space for peaceful, scientific and humanitarian objectives."

CONCLUSION

May I therefore summarize the present situation as follows:

(1) Rockets, high altitude guided missiles, satellites and future spaceships are not aircraft and their flight is not governed by any existing agreement or regulation.

(2) States have sovereignty in the airspace above their surface territories and the right to control flight therein. This airspace includes only areas where sufficient gaseous atmosphere exists to provide aerodynamic lift for such flight instrumentalities as balloons and aircraft.

(3) Rockets, guided missiles, and satellites are actually being used today in areas of outer space beyond the territorial sphere of any state, entirely unregulated, and beyond the rule of law.

(4) No agreement exists as to where the boundary is between the territorial airspace of a state and outer space beyond—nor as to the legal status of the intermediate area lying between the territorial airspace and outer space, in which intermediate area the presence of a certain amount of gaseous atmosphere may cause the fall of flight instrumentalities, thus endangering the state below.

(5) Only the United Nations has sufficiently broad international membership to be used as the forum to determine the extent of future international agreement as to the area included in the territorial airspace of sovereign states, and how, when and where control should be vested to assure that outer space is used solely for peaceful and scientific purposes.

These are problems which the American lawyer can no longer afford to disregard.

Flight Space and the Satellites

Address by

John Cobb Cooper [1] at a meeting of British Branch of the International Law Association on November 27, 1957, at the Institute of Advanced Legal Studies, London University

On October 4, 1957, the U. S. S R launched the first manmade satellite and a second about a month later Both were equipped with wireless transmitters. Although these are no longer heard, both Sputnik I and Sputnik II are still encircling the earth several times each day. An entirely new era in transport is opening up before us.

To the international lawyer, three problems are of immediate importance:

First, what is the legal status of those areas of flight space used in the launching and eventual passage of the satellite?

Second, what is the legal status of the satellite itself?

Third, what international questions of future control of such flights and, indeed, flight space must be answered?

The launching of these Russian satellites emphasizes the fact that International Air Law, or as I would prefer to call it, international flight space law, is in one of its periods of major development The last such period was roughly between 1909 and 1919. That was the period when states in the international community were gradually accepting the basic rule that the airspace is part of the territory of the state below, and that such airspace over the high seas is free for international flight as the high seas themselves are for international shipping.

In that development London University had its part. On December 7, 1910, Prof. Harold D. Hazeltine, an American by birth though an English professor of law by training and practice, then lecturing regularly at Cambridge, delivered the first of his three lectures on "The Law of the Air" at the University of London, by request of the faculty of law (1). These were the earliest academic air law lectures ever given in the English language. The subject of his first lecture was: "The Fundamental Problem: The Rights of States in the Airspace" Professor Hazeltine brilliantly supported the position that each state is sovereign in the air space over its land and waters. The same position had been urged in Italy by Anzilotti (later to become a judge of the World Court), in Germany by Zittelmann and others, and in particular by Lycklama a Nijeholt, who had just published in English and French, and perhaps in her native Dutch, a farsighted and now classic treatise on "Air Sovereignty (2)."

The legal historian must, however, be more interested in the acts of sovereign states than in the arguments of jurists when determining the accepted rules of public international law. The period between 1909 and 1919 is replete with clear proof of such acts, demonstrating the validity of the statement that the airspace over a state is part of the territory of that state—that is to say, that national territory is three-dimensional.

A student wishing to pursue this subject will find no lack of material. It begins perhaps in 1908–09 when France protested to Germany against the flight of military balloons across the frontier, which Clemenceau, as French Minister of the Interior, sought to handle by having the balloons themselves seized for failure of the pilot to pay duty while crossing the frontier. There followed the call by France for the first International Conference on the Regulation of Air Navigation; then the holding of this Conference in Paris in 1910, at which a definite treaty was almost agreed upon, and parts of which greatly influenced the later Paris Convention of 1919 and through that convention the Chicago Convention of 1944 (3).

On the failure of international agreement, states acted quickly, by unilateral legislation or decree, to make effective their claims of the right to control flight over their territories Noteworthy was the British Act in 1911, followed by French and other decrees. In 1913 France and Germany signed the celebrated agreement severely limiting flight across their boundary Restrictive zones were named in which no flight was permitted.

In the excited days immediately preceding World War I, national air boundaries were closed. When Germany declared war on France, part of the little known actual Declaration of War recited the alleged violation of German and Belgian airspace by French military aircraft. Neutral states, by decree, denied the right

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of belligerent aircraft to fly over their territories and vigorously enforced these decrees during World War I (4). The period culminated in the adoption of the great Paris Convention of 1919. Its first article recognized that "every power has complete and exclusive sovereignty over the airspace above its territory."

Since 1919 no state has questioned seriously the position that "airspace" is part of the territory of the state below. The position has been reaffirmed in the statutes and decrees of many states, including the U. S. S R and other states not parties to the Paris Convention, and has been repeated in the presently effective Chicago Convention of 1944.

The great formative 1909–19 period was thus characterized by the extension of national territory upward into the space above. The new and equally important period through which we are now passing will, in my judgment, be characterized by international acceptance of very definite upper limits on territorial sovereignty, and the determination that all areas above such limits are free for the use of all states. This is the period of limitation of sovereignty, and not of the creation of sovereignty.

The term "flight space" was suggested by me in 1951 in two definitions which I put forward in an effort to simplify legal thinking in an era when rocket flight already existed and satellite flight was already foreseen, and when the term "airspace" was rapidly becoming a vehicle for confused rather than accurate international thinking. These definitions were as follows:

"Flight" includes any movement through space of man-operated or man-controlled devices or instrumentalities (to be known as flight instrumentalities), such as balloons, dirigibles, airplanes, rockets, guided missiles, or spaceships

"Flightspace" means so much of universal space above and beyond the surface of the earth as is now used or may hereafter be used as the area in which flight takes place (5).

In his recent excellent article on "International Law and High Altitude Flights," (6) Dr. Bin Cheng of University College, London, has revived the suggested term "flight space" and deals with it as consisting of two parts, namely "airspace" and "outer space." The result may be the same as my earlier definition. His definition has the advantage that it emphasizes the dilemma before us: Where is the boundary between the "airspace" which is part of the national territory of the state below, and "outer space?"

Much has been written, but little has been decided, as to what is meant by the term "airspace" It was certainly not discussed at the Chicago Conference in 1944. The drafting committee of which I then had the honor to be chairman presented the present article I of the Chicago convention in almost the exact language of the Paris convention of 1919—namely, every state has complete and exclusive sovereignty over the airspace above its territory. After many years of careful research, I am convinced that the term "airspace," as used in the Paris convention of 1919, was there meant to include only those parts of the atmosphere above the surface of the earth where gaseous air is sufficiently dense to support balloons and airplanes, the only types of aircraft then in existence. The annexes to the Paris convention describe an aircraft as "any machine that can derive support in the atmosphere from the reactions of the air." These annexes were part of the Paris convention.

The annexes to the Chicago convention of 1944 now in force, although legally not part of the convention, have been accepted by member states, which include practically all of the great flying nations with the exception of the U. S. S R. The definition of "aircraft" in the annexes to the Chicago convention is the same as that in the annexes to the Paris convention.

My views today are just as they were in 1956 when these matters were discussed at some length at the annual meeting of the American Society of International Law (7). I then said what I now wish to repeat, namely

"The Chicago convention contains no definition of 'airspace,' but it may well be argued that, as it was adapted from the Paris convention, it deals with no areas of space other than those parts of the atmosphere where the gaseous air is sufficiently dense to support balloons and airplanes * * *.

"Nothing in the Chicago convention precludes the possibility of state sovereignty being extended by international agreement, or by unilateral force, above the areas in which the airplane and balloon can be used, but there is certainly no basis on which any customary international law can as yet be considered applicable to such higher areas"

Any careful reading of what I said then and have since said as to possible further upward extension of air sovereignty (8) will disclose that I have always insisted that an agreement would be needed before national soveriegnty of any

state could be recognized in areas above those where sufficiently dense gaseous atmosphere will exist to provide aeronautical lift for airplanes and balloons.

It may be useful to examine the present status of the practical use now being made of this atmospheric space.

During the past year, on August 19, 1957, Major Simons in the United States ascended in a specially constructed balloon to a distance of approximately 100,000 feet, or somewhat over 19 miles (9). On August 28, 1957, a Canberra B–2 aircraft in the United Kingdom was credited with an official altitude height of approximately 70,100 feet, or about 13 miles, which I believe is the highest official record to date. In September 1956, the experimental craft known as X–2, driven by rocket motors, was destroyed with all its instruments on a flight in which its pilot was killed. Unofficially, this rocket-powered aircraft was understood to have reached speeds of at least 1,900 miles per hour, and to have attained a height of approximately 24 miles (10).

Without becoming too technical, I must remind you that there are two factors which limit the height to which an aircraft may proceed. One is the aeronautical lift provided by its design, the other is a question of motive power. Normal types of aircraft engines, both piston driven, turboprop, or jet, are to some extent "air breathing," that is to say, their effectiveness depends on taking gaseous oxygen out of surrounding air and using it in combination with petrol or other fuel to drive the motor. On the other hand, the rocket engine carries its own oxygen supply in its self-contained fuel. A rocket engine, therefore, operates equally well through the atmosphere and through space beyond. The X–2 is understood to have had such rocket power. In the flight of the Canberra B–2 referred to above, I am advised that jet power was used up to about 40,000 feet, and at that point rocket power was turned on, and not turned off until the aircraft had reached its recorded maximum height of 70,000 feet.

Although rocket power has thus made it possible for aircraft requiring atmospheric support to ascend far above the areas where they might be driven by older powerplants, nevertheless I do not feel that the legal position has been altered. They are still operating within the "airspace" which is part of the territory of the state below. However, a new and completely different problem will arise if future types of aircraft, driven by rocket power, ascend through the atmosphere in normal flight, and then continue beyond as a rocket-powered space craft. Reference has recently been made to an aircraft, described as X–15, which it is said "should go up 100 miles at 3,500 miles per hour" (11). About this aircraft I know nothing further. But if it is put successfully into flight, I am quite certain as a lawyer that it will ascend far beyond the areas of atmospheric space which are admittedly part of the territory of the state below.

Returning then to the major problem as to where territorial "airspace" ends and where "outer space" begins, I must direct your attention to a series of international events which appear to indicate the beginning of a new rule of customary international law holding that "outer space" is not part of the territory of the state below.

In 1956 the United States announced a program of planned satellite flights in aid of the International Geophysical Year. The proposed satellites were to contain instruments to study various physical phenomena, the details of which are not important here. Shortly afterward the U. S. S. R. indicated a similar plan. So far as I can ascertain neither the United States nor the U. S. S. R. asked any formal permission of other states to place the proposed satellites in space several hundred miles above those parts of the earth which would be covered by the flight orbits. On the other hand, as is well known, no international flight by aircraft of any state through the atmospheric territorial space of another state is permissible without the general or specific authority of the state affected.

Also no record exists that any state protested against the proposed international satellite flights. While it has been suggested that the various agreements between the scientific committees promoting the Geophysical Year may have been supported sufficiently by the several governments concerned as to be considered legally equivalent to international agreements permitting such satellite flights, this argument would fail insofar as those states are concerned which are not part of the Geophysical Year program and over whose territories the satellites would proceed.

Next, in order of time, was the statement in President Eisenhower's January 1957 state of the Union message to the effect that the United States was willing to enter into any reliable agreements which would mutually control the outer space missile and satellite development (12). A few days later, the United States representative to the United Nations, addressing a committee of the General Assembly, is reported in the press to have said that "the first step toward the

objective of assuring that developments in outer space would be devoted exclusively to peaceful and scientific purposes would be to bring the testing of such objects under international inspection and participation" (13).

Later, in July, a proposal was put before the Subcommittee of the Disarmament Commission meeting in London, which suggested the inclusion in a possible disarmament convention of the following

"THE CONTROL OF OBJECTS ENTERING OUTER SPACE

"All parties to the convention agree that within 3 months after the entry into effect of the convention they will cooperate in the establishment of a technical committee to study the design of an inspection system which would make it possible to assure that the sending of objects through outer space will be exclusively for peaceful and scientific purposes" (14).

This was supported by Canada, France, the United Kingdom, and the United States.

Sputnik I was launched on October 4, 1957. The satellite itself, as well as the last stage of the rocket which launched it, are still circling the earth several times daily. The course of the orbit is such that they have probably passed over the surface territory of every member of the United Nations, and many other states as well. I have not been able to find any record that states have protested against such flights as violating their territorial rights

While these flights were continuing, disarmament proposals were adopted by the Political Committee of the United Nations on November 6 (15). A resolution sponsored by Canada, France, the United Kingdom, the United States, and a number of other nations stated that the Disarmament Subcommittee should give priority to reaching a disarmament agreement which, on entering into force, would provide for various things, including the "joint study of an inspection system designed to insure that the sending of objects through outer space will be exclusively for peaceful and scientific purposes." This is practically the same proposal earlier suggested in the Disarmament Subcommittee.

According to very recent press reports, the Political Committee proposal has been approved by the Assembly of the United Nations

Taking all of these official and semiofficial acts together, I feel as a lawyer that the course of international conduct since the satellite flights were first announced is consistent with no theory other than the acceptance of the principle that "outer space" is not part of the territory of any state and may be used by all states as freely as the high seas are now used for surface shipping.

This emphasizes, however, the present major difficulty—what is meant by "outer space"? I submit for your consideration that immediately above the area of admitted national sovereignty, namely where sufficient gaseous atmosphere exists to support aircraft or balloon flight, is an area in which there appears to be sufficient gaseous atmosphere to affect flight. The Mullard Radio Astronomy Observatory at Cambridge, whose brilliant work in the technical observations of the sputnik flights I cannot praise too highly, advises me as follows: Minimum height of the orbit of Sputnik I is about 200 kilometers (about 125 miles) above the earth's surface, and its maximum is about 930 kilometers (about 590 miles). The minimum height of the orbit of Sputnik II is again about 200 kilometers (125 miles) above us and at the maximum about 1,600 kilometers (about 1,000 miles). The orbit time of Sputnik I decreased initially by 2 seconds a day, indicating a decrease in the maximum height of the satellite of about 3.5 kilometers (2$\frac{2}{10}$ miles) a day, and the orbit time of Sputnik II decreased at about the same rate, corresponding to a similar decrease in the maximum height of the orbit as in the case of Sputnik I. I have roughly transposed the figures in kilometers furnished me by the Mullard Laboratory into miles for the purpose of the present discussion.

The importance of these figures is that they seem to constitute definite proof that the lower portion of the orbits of both Sputnik I and Sputnik II are closer to the earth than some earlier scientific analyses had deemed practical for effective satellite flight. At the same time, the figures show that these lower parts of the orbit must be within an area in which there is sufficient gaseous atmosphere to create some "drag" so as to affect the period of time during which the statellites smay continue on their courses. The same lower parts of the orbits are, however, above these atmospheric areas which would cause heating so as to destroy the satellites. They will doubtless continue on their orbits until they reach those dense lower strata where destruction may well result from the enormous heat created by an object proceeding at 18,000 miles an hour.

To sum up my views: I believe we are entering a period where international conduct as well as legal doctrine will demonstrate:

(a) that the present territory of every state extends upward only to a point where gaseous air becomes so thin as to provide no aeronautical lift supporting flights of aircraft or balloons;

(b) that "outer space," where there is no atmosphere of sufficient density to create "drag" or otherwise affect flight, is now beyond the sovereignty of any state;

(c) that an international decision must be made by treaty, or otherwise, to determine the exact future status of those areas of atmospheric space which lie between the areas of practical aeronautical lift and the areas referred to in (b) above as "outer space"

The remaining two problems may be dealt with briefly. It is obvious from what has been said earlier that a satellite is not an aircraft subject to the present existing international regulations However, I submit, it is quite necessary that this future formal international agreement should provide means for such regulation. Such an agreement will certainly require that the state responsible for the launching of the satellite will also be subsequently responsible for its international good conduct.

So far as future regulations of areas of "outer space" which are not part of the sovereignty of any state are concerned, you may be interested in the recommendations very recently made by a distinguished group in the United States (of which I am not a member) known as the Commission to Study the Organization of Peace. It is the research affiliate of the American Association for the United Nations. In this report (16) the Commission has recommended that the United Nations undertake the responsibility of administering certain areas "which are outside the jurisdiction of any state" including "outer space," and that the General Assembly declare the title of the international community and establish the appropriate administrative arrangements. In the detailed statement by a study group of the Commission on which these recommendations are based, it was urged that the principle should be accepted that outer space is not subject to ownership or control by individual states, but only by the international community, represented by the United Nations. In the alternative, it was suggested that international ownership and operation of all or certain types of space craft and verification of flights be adopted as a short-term policy regarding earth satellites, but only after more than one nation had launched such a satellite. These recommendations were drafted before Sputnik I was launched.

Such proposals pose questions of future international policy. It is the primary province of the international lawyer to determine the present status of the law. At the Washington meeting of the Society of International Law, I went further and suggested for future consideration possible extension of sovereignty by agreement up to 300 miles above the surface of the earth, so as to include areas of "drag." Such a suggestion was entirely tentative, as I said, depending upon what was found in the research of the Geophysical Year as to actual conditions in upper atmospheric space (17). Very recently, in a letter to the London Times (18), I suggested that it might be advisable to extend such sovereignty by agreement up to 600 miles as part of any disarmament agreement, so as to protect neutral states from the uncontrollable flight of guided missiles on high trajectories. These are nothing more than statements of my personal views as to possible international policy. They do not in any way change the carefully considered views which I have expressed earlier with reference to the present status of the law.

In conclusion, may I ask that you understand that nothing here put forward is stated as the views of any organization with which I am associated or any committees of which I am a member Recently the International Astronautical Federation set up a committee which is charged with preparing a statement for possible submission to the United Nations and the International Civil Aviation Organization regarding the extent of the airspace and the resulting jurisdictional problems. With reluctance I accepted the chairmanship of this committee. I do not want either those of you who are here today or my colleagues on that committee to think that I have sought to prejudge any decision which the committee may hereafter make

NOTES

(1) Harold D Hazeltine, The Law of the Air University of London Press, 1911

(2) Lycklama a Nijeholt, Air Sovereignty. The Hague, 1910, page 46, where she said: "We therefore conclude that state sovereignty reaches quite as high as the state's interest can reach, the possibility of which but ends at the uttermost

limit of the atmosphere * * * In principle the airspace belongs to the sovereign state territory, so the state has full sovereignty to an unlimited height, which sovereignty can only be abolished or restricted by treaty."

(3) Cooper, "The International Air Navigation Conference, Paris 1910," Journal of Air Law and Commerce, volume 19, 1952, pages 127–143.

(4) Cooper, "State Sovereignty in Space: Developments, 1910 to 1914," included in Beitrage zum Internationalen Luftrecht. Dusseldorf, 1954.

(5) Cooper, "Air Law, A Field for International Thinking," Transport and Communications Review (United Nations), volume 4, No. 4, October–December, 1951, pages 1–7.

(6) Cheng, "International Law and High Altitude Flights: Balloons, Rockets and Manmade Satellites," International and Comparative Law Quarterly, July 1957, pages 487–505

7. Cooper, "Legal Problems of Upper Space," Proceedings of the American Society of International Law, 1956, page 85. For an earlier discussion of these problems, see Cooper, "High Altitude Flights and National Sovereignty," International Law Quarterly, volume 4, 1951, page 411.

(8) Letter to The Times (London), September 2, 1957, published under the title "Who Owns the Upper Air?"

(9) See Life (international edition), November 11, 1957, page 25.

(10) See Aviation Week, October 1, 1956.

(11) See note 9. See also for a statement without estimates of possible results, "Space Flight," volume 1, No. 5 (October 1957), page 190

(12) New York Times, January 11, 1957, page 9.

(13) New York Times, January 15, 1957, page 4.

(14) Fifth report, subcommittee of Disarmament Commission, DC. 11311, September 1957. Annex 5 DC.SC. 1/66. August 29, 1957.

(15) The Times (London), November 7, 1957.

(16) Strengthening the United Nations. Harper & Bros., New York, 1957.

(17) See note 7.

(18) See note 8.

(Executive O is in the committee files. The text of the Chicago convention follows:)

CONVENTION ON INTERNATIONAL CIVIL AVIATION

PREAMBLE

WHEREAS the future development of international civil aviation can greatly help to create and preserve friendship and understanding among the nations and peoples of the world, yet its abuse can become a threat to the general security; and

WHEREAS it is desirable to avoid friction and to promote that cooperation between nations and peoples upon which the peace of the world depends;

THEREFORE, the undersigned governments having agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically;

Have accordingly concluded this Convention to that end.

PART I. AIR NAVIGATION

CHAPTER I

GENERAL PRINCIPLES AND APPLICATION OF THE CONVENTION

Article 1

The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory. Sovereignty

Article 2

For the purposes of this Convention the territory of a State shall be deemed to be the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection or mandate of such State. Territory

Article 3

(a) This Convention shall be applicable only to civil aircraft, and shall not be applicable to state aircraft. Civil and state aircraft

(b) Aircraft used in military, customs and police services shall be deemed to be state aircraft.

(c) No state aircraft of a contracting State shall fly over the territory of another State or land thereon without authorization by special agreement or otherwise, and in accordance with the terms thereof.

(d) The contracting States undertake, when issuing regulations for their state aircraft, that they will have due regard for the safety of navigation of civil aircraft.

Article 4

Misuse of civil aviation

Each contracting State agrees not to use civil aviation for any purpose inconsistent with the aims of this Convention.

CHAPTER II

FLIGHT OVER TERRITORY OF CONTRACTING STATES

Article 5

Right of non-scheduled flight

Each contracting State agrees that all aircraft of the other contracting States, being aircraft not engaged in scheduled international air services shall have the right, subject to the observance of the terms of this Convention, to make flights into or in transit non-stop across its territory and to make stops for non-traffic purposes without the necessity of obtaining prior permission, and subject to the right of the State flown over to require landing. Each contracting State nevertheless reserves the right, for reasons of safety of flight, to require aircraft desiring to proceed over regions which are inaccessible or without adequate air navigation facilities to follow prescribed routes, or to obtain special permission for such flights.

Such aircraft, if engaged in the carriage of passengers, cargo, or mail for remuneration or hire on other than scheduled international air services, shall also, subject to the provisions of Article 7, have the privilege of taking on or discharging passengers, cargo, or mail, subject to the right of any State where such embarkation or discharge takes place to impose such regulations, conditions or limitations as it may consider desirable.

Article 6

Scheduled air services

No scheduled international air service may be operated over or into the territory of a contracting State, except with the special permission or other authorization of that

State, and in accordance with the terms of such permission or authorization.

Article 7

Each contracting State shall have the right to refuse permission to the aircraft of other contracting States to take on in its territory passengers, mail and cargo carried for remuneration or hire and destined for another point within its territory. Each contracting State undertakes not to enter into any arrangements which specifically grant any such privilege on an exclusive basis to any other State or an airline of any other State, and not to obtain any such exclusive privilege from any other State. Cabotage

Article 8

No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft. Pilotless aircraft

Article 9

(a) Each contracting State may, for reasons of military necessity or public safety, restrict or prohibit uniformly the aircraft of other States from flying over certain areas of its territory, provided that no distinction in this respect is made between the aircraft of the State whose territory is involved, engaged in international scheduled airline services, and the aircraft of the other contracting States likewise engaged. Such prohibited areas shall be of reasonable extent and location so as not to interfere unnecessarily with air navigation. Descriptions of such prohibited areas in the territory of a contracting State, as well as any subsequent alterations therein, shall be communicated as soon as possible to the other contracting States and to the International Civil Aviation Organization. Prohibited areas

(b) Each contracting State reserves also the right, in exceptional circumstances or during a period of emergency, or in the interest of public safety, and with immediate effect, temporarily to restrict or prohibit flying over the whole or any part of its territory, on condition that

such restriction or prohibition shall be applicable without distinction of nationality to aircraft of all other States.

(c) Each contracting State, under such regulations as it may prescribe, may require any aircraft entering the areas contemplated in subparagraphs (a) or (b) above to effect a landing as soon as practicable thereafter at some designated airport within its territory.

Article 10

Landing at customs airport

Except in a case where, under the terms of this Convention or a special authorization, aircraft are permitted to cross the territory of a contracting State without landing, every aircraft which enters the territory of a contracting State shall, if the regulations of that State so require, land at an airport designated by that State for the purpose of customs and other examination. On departure from the territory of a contracting State, such aircraft shall depart from a similarly designated customs airport. Particulars of all designated customs airports shall be published by the State and transmitted to the International Civil Aviation Organization established under Part II of this Convention for communication to all other contracting States.

Article 11

Applicability of air regulations

Subject to the provisions of this Convention, the laws and regulations of a contracting State relating to the admission to or departure from its territory of aircraft engaged in international air navigation, or to the operation and navigation of such aircraft while within its territory, shall be applied to the aircraft of all contracting States without distinction as to nationality, and shall be complied with by such aircraft upon entering or departing from or while within the territory of that State.

Article 12

Rules of the air

Each contracting State undertakes to adopt measures to insure that every aircraft flying over or maneuvering within its territory and that every aircraft carrying its nationality mark, wherever such aircraft may be, shall comply with the rules and regulations relating to the flight and maneuver of aircraft there in force. Each contracting State undertakes to keep its own regulations in these respects uniform, to the greatest possible extent,

with those established from time to time under this Convention. Over the high seas, the rules in force shall be those established under this Convention. Each contracting State undertakes to insure the prosecution of all persons violating the regulations applicable.

Article 13

Entry and clearance regulations

The laws and regulations of a contracting State as to the admission to or departure from its territory of passengers, crew or cargo of aircraft, such as regulations relating to entry, clearance, immigration, passports, customs, and quarantine shall be complied with by or on behalf of such passengers, crew or cargo upon entrance into or departure from, or while within the territory of that State.

Article 14

Prevention of spread of disease

Each contracting State agrees to take effective measures to prevent the spread by means of air navigation of cholera, typhus (epidemic), smallpox, yellow fever, plague, and such other communicable diseases as the contracting States shall from time to time decide to designate, and to that end contracting States will keep in close consultation with the agencies concerned with international regulations relating to sanitary measures applicable to aircraft. Such consultation shall be without prejudice to the application of any existing international convention on this subject to which the contracting States may be parties.

Article 15

Airport and similar charges

Every airport in a contracting State which is open to public use by its national aircraft shall likewise, subject to the provisions of Article 68, be open under uniform conditions to the aircraft of all the other contracting States. The like uniform conditions shall apply to the use, by aircraft of every contracting State, of all air navigation facilities, including radio and meteorological services, which may be provided for public use for the safety and expedition of air navigation.

Any charges that may be imposed or permitted to be imposed by a contracting State for the use of such airports and air navigation facilities by the aircraft of any other contracting State shall not be higher,

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(a) As to aircraft not engaged in scheduled international air services, than those that would be paid by its national aircraft of the same class engaged in similar operations, and

(b) As to aircraft engaged in scheduled international air services, than those that would be paid by its national aircraft engaged in similar international air services.

All such charges shall be published and communicated to the International Civil Aviation Organization: provided that, upon representation by an interested contracting State, the charges imposed for the use of airports and other facilities shall be subject to review by the Council, which shall report and make recommendations thereon for the consideration of the State or States concerned. No fees, dues or other charges shall be imposed by any contracting State in respect solely of the right of transit over or entry into or exit from its territory of any aircraft of a contracting State or persons or property thereon.

Article 16

Search of aircraft

The appropriate authorities of each of the contracting States shall have the right, without unreasonable delay, to search aircraft of the other contracting States on landing or departure, and to inspect the certificates and other documents prescribed by this Convention.

CHAPTER III

NATIONALITY OF AIRCRAFT

Article 17

Nationality of aircraft

Aircraft have the nationality of the State in which they are registered.

Article 18

Dual registration

An aircraft cannot be validly registered in more than one State, but its registration may be changed from one State to another.

Article 19

National laws governing registration

The registration or transfer of registration of aircraft in any contracting State shall be made in accordance with its laws and regulations.

Article 20

Every aircraft engaged in international air navigation shall bear its appropriate nationality and registration marks. Display of marks

Article 21

Each contracting State undertakes to supply to any other contracting State or to the International Civil Aviation Organization, on demand, information concerning the registration and ownership of any particular aircraft registered in that State. In addition, each contracting State shall furnish reports to the International Civil Aviation Organization, under such regulations as the latter may prescribe, giving such pertinent data as can be made available concerning the ownership and control of aircraft registered in that State and habitually engaged in international air navigation. The data thus obtained by the International Civil Aviation Organization shall be made available by it on request to the other contracting States. Report of registrations

Chapter IV

MEASURES TO FACILITATE AIR NAVIGATION

Article 22

Each contracting State agrees to adopt all practicable measures, through the issuance of special regulations or otherwise, to facilitate and expedite navigation by aircraft between the territories of contracting States, and to prevent unnecessary delays to aircraft, crews, passengers and cargo, especially in the administration of the laws relating to immigration, quarantine, customs and clearance. Facilitation of formalities

Article 23

Each contracting State undertakes, so far as it may find practicable, to establish customs and immigration procedures affecting international air navigation in accordance with the practices which may be established or recommended from time to time, pursuant to this Convention. Nothing in this Convention shall be construed as preventing the establishment of customs-free airports. Customs and immigration procedures

Article 24

(a) Aircraft on a flight to, from, or across the territory of another contracting State shall be admitted tem- Customs duty

porarily free of duty, subject to the customs regulations of the State. Fuel, lubricating oils, spare parts, regular equipment and aircraft stores on board an aircraft of a contracting State, on arrival in the territory of another contracting State and retained on board on leaving the territory of that State shall be exempt from customs duty, inspection fees or similar national or local duties and charges. This exemption shall not apply to any quantities or articles unloaded, except in accordance with the customs regulations of the State, which may require that they shall be kept under customs supervision.

(b) Spare parts and equipment imported into the territory of a contracting State for incorporation in or use on an aircraft of another contracting State engaged in international air navigation shall be admitted free of customs duty, subject to compliance with the regulations of the State concerned, which may provide that the articles shall be kept under customs supervision and control.

Article 25

Aircraft in distress

Each contracting State undertakes to provide such measures of assistance to aircraft in distress in its territory as it may find practicable, and to permit, subject to control by its own authorities, the owners of the aircraft or authorities of the State in which the aircraft is registered to provide such measures of assistance as may be necessitated by the circumstances. Each contracting State, when undertaking search for missing aircraft, will collaborate in coordinated measures which may be recommended from time to time pursuant to this Convention.

Article 26

Investigation of accidents

In the event of an accident to an aircraft of a contracting State occurring in the territory of another contracting State, and involving death or serious injury, or indicating serious technical defect in the aircraft or air navigation facilities, the State in which the accident occurs will institute an inquiry into the circumstances of the accident, in accordance, so far as its laws permit, with the procedure which may be recommended by the International Civil Aviation Organization. The State in which the aircraft is registered shall be given the opportunity to appoint observers to be present at the inquiry and the State holding the inquiry shall commu-

nicate the report and findings in the matter to that State.

Article 27

(a) While engaged in international air navigation, any authorized entry of aircraft of a contracting State into the territory of another contracting State or authorized transit across the territory of such State with or without landings shall not entail any seizure or detention of the aircraft or any claim against the owner or operator thereof or any other interference therewith by or on behalf of such State or any person therein, on the ground that the construction, mechanism, parts, accessories or operation of the aircraft is an infringement of any patent, design, or model duly granted or registered in the State whose territory is entered by the aircraft, it being agreed that no deposit of security in connection with the foregoing exemption from seizure or detention of the aircraft shall in any case be required in the State entered by such aircraft. Exemption from seizure on patent claims

(b) The provisions of paragraph (a) of this Article shall also be applicable to the storage of spare parts and spare equipment for the aircraft and the right to use and install the same in the repair of an aircraft of a contracting State in the territory of any other contracting State, provided that any patented part or equipment so stored shall not be sold or distributed internally in or exported commercially from the contracting State entered by the aircraft.

(c) The benefits of this Article shall apply only to such States, parties to this Convention, as either (1) are parties to the International Convention for the Protection of Industrial Property and to any amendments thereof; or (2) have enacted patent laws which recognize and give adequate protection to inventions made by the nationals of the other States parties to this Convention.

Article 28

Each contracting State undertakes, so far as it may find practicable, to: Air navigation facilities and standard systems

(a) Provide, in its territory, airports, radio services, meteorological services and other air navigation facilities to facilitate international air navigation, in accordance with the standards and practices recom-

mended or established from time to time, pursuant to this Convention;

(b) Adopt and put into operation the appropriate standard systems of communications procedure, codes, markings, signals, lighting and other operational practices and rules which may be recommended or established from time to time, pursuant to this Convention;

(c) Collaborate in international measures to secure the publication of aeronautical maps and charts in accordance with standards which may be recommended or established from time to time, pursuant to this Convention.

CHAPTER V

CONDITIONS TO BE FULFILLED WITH RESPECT TO AIRCRAFT

Article 29

Documents carried in aircraft

Every aircraft of a contracting State, engaged in international navigation, shall carry the following documents in conformity with the conditions prescribed in this Convention:

(a) Its certificate of registration;

(b) Its certificate of airworthiness;

(c) The appropriate licenses for each member of the crew;

(d) Its journey log book;

(e) If it is equipped with radio apparatus, the aircraft radio station license;

(f) If it carries passengers, a list of their names and places of embarkation and destination;

(g) If it carries cargo, a manifest and detailed declarations of the cargo.

Article 30

Aircraft radio equipment

(a) Aircraft of each contracting State may, in or over the territory of other contracting States, carry radio transmitting apparatus only if a license to install and operate such apparatus has been issued by the appropriate authorities of the State in which the aircraft is registered. The use of radio transmitting apparatus in the territory of the contracting State whose territory is flown over shall be in accordance with the regulations prescribed by that State.

(b) Radio transmitting apparatus may be used only by members of the flight crew who are provided with a special license for the purpose, issued by the appropriate authorities of the State in which the aircraft is registered.

Article 31

Certificates of airworthiness

Every aircraft engaged in international navigation shall be provided with a certificate of airworthiness issued or rendered valid by the State in which it is registered.

Article 32

Licenses of personnel

(a) The pilot of every aircraft and the other members of the operating crew of every aircraft engaged in international navigation shall be provided with certificates of competency and licenses issued or rendered valid by the State in which the aircraft is registered.

(b) Each contracting State reserves the right to refuse to recognize, for the purpose of flight above its own territory, certificates of competency and licenses granted to any of its nationals by another contracting State.

Article 33

Recognition of certificates and licenses

Certificates of airworthiness and certificates of competency and licenses issued or rendered valid by the contracting State in which the aircraft is registered, shall be recognized as valid by the other contracting States, provided that the requirements under which such certificates or licenses were issued or rendered valid are equal to or above the minimum standards which may be established from time to time pursuant to this Convention.

Article 34

Journey log books

There shall be maintained in respect of every aircraft engaged in international navigation a journey log book in which shall be entered particulars of the aircraft, its crew and of each journey, in such form as may be prescribed from time to time pursuant to this Convention.

Article 35

Cargo restrictions

(a) No munitions of war or implements of war may be carried in or above the territory of a State in aircraft engaged in international navigation, except by permission of such State. Each State shall determine by regulations what constitutes munitions of war or implements

of war for the purposes of this Article, giving due consideration, for the purposes of uniformity, to such recommendations as the International Civil Aviation Organization may from time to time make.

(b) Each contracting State reserves the right, for reasons of public order and safety, to regulate or prohibit the carriage in or above its territory of articles other than those enumerated in paragraph (a): provided that no distinction is made in this respect between its national aircraft engaged in international navigation and the aircraft of the other States so engaged; and provided further that no restriction shall be imposed which may interfere with the carriage and use on aircraft of apparatus necessary for the operation or navigation of the aircraft or the safety of the personnel or passengers.

Article 36

Photographic apparatus

Each contracting State may prohibit or regulate the use of photographic apparatus in aircraft over its territory.

Chapter VI

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

Article 37

Adoption of international standards and procedures

Each contracting State undertakes to collaborate in securing the highest practicable degree of uniformity in regulations, standards, procedures, and organization in relation to aircraft, personnel, airways and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation.

To this end the International Civil Aviation Organization shall adopt and amend from time to time, as may be necessary, international standards and recommended practices and procedures dealing with:

(a) Communications systems and air navigation aids, including ground marking;

(b) Characteristics of airports and landing areas;

(c) Rules of the air and air traffic control practices;

(d) Licensing of operating and mechanical personnel;

(e) Airworthiness of aircraft;

(f) Registration and identification of aircraft;

(g) Collection and exchange of meteorological information;

(h) Log books;

(i) Aeronautical maps and charts;

(j) Customs and immigration procedures;

(k) Aircraft in distress and investigation of accidents;

and such other matters concerned with the safety, regularity, and efficiency of air navigation as may from time to time appear appropriate.

Article 38

Departures from international standards and procedures

Any State which finds it impracticable to comply in all respects with any such international standard or procedure, or to bring its own regulations or practices into full accord with any international standard or procedure after amendment of the latter, or which deems it necessary to adopt regulations or practices differing in any particular respect from those established by an international standard, shall give immediate notification to the International Civil Aviation Organization of the differences between its own practice and that established by the international standard. In the case of amendments to international standards, any State which does not make the appropriate amendments to its own regulations or practices shall give notice to the Council within sixty days of the adoption of the amendment to the international standard, or indicate the action which it proposes to take. In any such case, the Council shall make immediate notification to all other states of the difference which exists between one or more features of an international standard and the corresponding national practice of that State.

Article 39

Endorsement of certificates and licenses

(a) Any aircraft or part thereof with respect to which there exists an international standard of airworthiness or performance, and which failed in any respect to satisfy that standard at the time of its certification, shall have endorsed on or attached to its airworthiness certificate a complete enumeration of the details in respect of which it so failed.

(b) Any person holding a license who does not satisfy in full the conditions laid down in the international standard relating to the class of license or certificate which he holds shall have endorsed on or attached to his license a complete enumeration of the particulars in which he does not satisfy such conditions.

Article 40

Validity of endorsed certificates and licenses

No aircraft or personnel having certificates or licenses so endorsed shall participate in international navigation, except with the permission of the State or States whose territory is entered. The registration or use of any such aircraft, or of any certificated aircraft part, in any State other than that in which it was originally certificated shall be at the discretion of the State into which the aircraft or part is imported.

Article 41

Recognition of existing standards of airworthiness

The provisions of this Chapter shall not apply to aircraft and aircraft equipment of types of which the prototype is submitted to the appropriate national authorities for certification prior to a date three years after the date of adoption of an international standard of airworthiness for such equipment.

Article 42

Recognition of existing standards of competency of personnel

The provisions of this Chapter shall not apply to personnel whose licenses are originally issued prior to a date one year after initial adoption of an international standard of qualification for such personnel; but they shall in any case apply to all personnel whose licenses remain valid five years after the date of adoption of such standard.

PART II. THE INTERNATIONAL CIVIL AVIATION ORGANIZATION

CHAPTER VII

THE ORGANIZATION

Article 43

Name and composition

An organization to be named the International Civil Aviation Organization is formed by the Convention. It

is made up of an Assembly, a Council, and such other bodies as may be necessary.

Article 44

Objectives

The aims and objectives of the Organization are to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to:

(a) Insure the safe and orderly growth of international civil aviation throughout the world;

(b) Encourage the arts of aircraft design and operation for peaceful purposes;

(c) Encourage the development of airways, airports, and air navigation facilities for international civil aviation;

(d) Meet the needs of the peoples of the world for safe, regular, efficient and economical air transport;

(e) Prevent economic waste caused by unreasonable competition;

(f) Insure that the rights of contracting States are fully respected and that every contracting State has a fair opportunity to operate international airlines;

(g) Avoid discrimination between contracting States;

(h) Promote safety of flight in international air navigation;

(i) Promote generally the development of all aspects of international civil aeronautics.

Article 45

Permanent seat

The permanent seat of the Organization shall be at such place as shall be determined at the final meeting of the Interim Assembly of the Provisional International Civil Aviation Organization set up by the Interim Agreement on International Civil Aviation signed at Chicago on December 7, 1944. The seat may be temporarily transferred elsewhere by decision of the Council.

Article 46

First meeting of Assembly

The first meeting of the Assembly shall be summoned by the Interim Council of the above-mentioned Provisional Organization as soon as the Convention has come into force, to meet at a time and place to be decided by the Interim Council.

Article 47

Legal capacity

The Organization shall enjoy in the territory of each contracting State such legal capacity as may be necessary for the performance of its functions. Full juridical personality shall be granted wherever compatible with the constitution and laws of the State concerned.

CHAPTER VIII

THE ASSEMBLY

Article 48

Meetings of Assembly and voting

(a) The Assembly shall meet annually and shall be convened by the Council at a suitable time and place. Extraordinary meetings of the Assembly may be held at any time upon the call of the Council or at the request of any ten contracting States addressed to the Secretary General.

(b) All contracting States shall have an equal right to be represented at the meetings of the Assembly and each contracting State shall be entitled to one vote. Delegates representing contracting States may be assisted by technical advisers who may participate in the meetings but shall have no vote.

(c) A majority of the contracting States is required to constitute a quorum for the meetings of the Assembly. Unless otherwise provided in this Convention, decisions of the Assembly shall be taken by a majority of the votes cast.

Article 49

Powers and duties of Assembly

The powers and duties of the Assembly shall be to:

(a) Elect at each meeting its President and other officers;

(b) Elect the contracting States to be represented on the Council, in accordance with the provisions of Chapter IX;

(c) Examine and take appropriate action on the reports of the Council and decide on any matter referred to it by the Council;

(d) Determine its own rules of procedure and establish such subsidiary commissions as it may consider to be necessary or desirable;

(e) Vote an annual budget and determine the financial arrangements of the Organization, in accordance with the provisions of Chapter XII;

(f) Review expenditures and approve the accounts of the Organization;

(g) Refer, at its discretion, to the Council, to subsidiary commissions, or to any other body any matter within its sphere of action;

(h) Delegate to the Council the powers and authority necessary or desirable for the discharge of the duties of the Organization and revoke or modify the delegations of authority at any time;

(i) Carry out the appropriate provisions of Chapter XIII;

(j) Consider proposals for the modification or amendment of the provisions of this Convention and, if it approves of the proposals, recommend them to the contracting States in accordance with the provisions of Chapter XXI;

(k) Deal with any matter within the sphere of action of the Organization not specifically assigned to the Council.

Chapter IX

THE COUNCIL

Article 50

Composition and election of Council

(a) The Council shall be a permanent body responsible to the Assembly. It shall be composed of twenty-one contracting States elected by the Assembly. An election shall be held at the first meeting of the Assembly and thereafter every three years, and the members of the Council so elected shall hold office until the next following election.

(b) In electing the members of the Council, the Assembly shall give adequate representation to (1) the States of chief importance in air transport; (2) the States not otherwise included which make the largest contribution to the provision of facilities for international civil air navigation; and (3) the States not otherwise included whose designation will insure that all the major geographic areas of the world are represented on the Council. Any vacancy on the Council shall be filled by the Assembly as soon as possible; any contracting State so elected

to the Council shall hold office for the unexpired portion of its predecessor's term of office.

(c) No representative of a contracting State on the Council shall be actively associated with the operation of an international air service or financially interested in such a service.

Article 51

President of Council

The Council shall elect its President for a term of three years. He may be reelected. He shall have no vote. The Council shall elect from among its members one or more Vice Presidents who shall retain their right to vote when serving as acting President. The President need not be selected from among the representatives of the members of the Council but, if a representative is elected, his seat shall be deemed vacant and it shall be filled by the State which he represented. The duties of the President shall be to:

(a) Convene meetings of the Council, the Air Transport Committee, and the Air Navigation Commission;

(b) Serve as representative of the Council; and

(c) Carry out on behalf of the Council the functions which the Council assigns to him.

Article 52

Voting in Council

Decisions by the Council shall require approval by a majority of its members. The Council may delegate authority with respect to any particular matter to a committee of its members. Decisions of any committee of the Council may be appealed to the Council by any interested contracting State.

Article 53

Participation without a vote

Any contracting State may participate, without a vote, in the consideration by the Council and by its committees and commissions of any question which especially affects its interests. No member of the Council shall vote in the consideration by the Council of a dispute to which it is a party.

Article 54

Mandatory functions of Council

The Council shall:

(a) Submit annual reports to the Assembly;

(b) Carry out the directions of the Assembly and discharge the duties and obligations which are laid on it by this Convention;

(c) Determine its organization and rules of procedure;

(d) Appoint and define the duties of an Air Transport Committee, which shall be chosen from among the representatives of the members of the Council, and which shall be responsible to it;

(e) Establish an Air Navigation Commission, in accordance with the provisions of Chapter X;

(f) Administer the finances of the Organization in accordance with the provisions of Chapters XII and XV;

(g) Determine the emoluments of the President of the Council;

(h) Appoint a chief executive officer who shall be called the Secretary General, and make provision for the appointment of such other personnel as may be necessary, in accordance with the provisions of Chapter XI;

(i) Request, collect, examine and publish information relating to the advancement of air navigation and the operation of international air services, including information about the costs of operation and particulars of subsidies paid to airlines from public funds;

(j) Report to contracting States any infraction of this Convention, as well as any failure to carry out recommendations or determinations of the Council;

(k) Report to the Assembly any infraction of this Convention where a contracting State has failed to take appropriate action within a reasonable time after notice of the infraction;

(l) Adopt, in accordance with the provisions of Chapter VI of this Convention, international standards and recommended practices; for convenience, designate them as Annexes to this Convention; and notify all contracting States of the action taken;

(m) Consider recommendations of the Air Navigation Commission for amendment of the Annexes and take action in accordance with the provisions of Chapter XX;

(n) Consider any matter relating to the Convention which any contracting State refers to it.

Article 55

The Council may:

Permissive functions of Council

(a) Where appropriate and as experience may show to be desirable, create subordinate air transport commissions on a regional or other basis and define groups of states or airlines with or through which it may deal to facilitate the carrying out of the aims of this Convention;

(b) Delegate to the Air Navigation Commission duties additional to those set forth in the Convention and revoke or modify such delegations of authority at any time;

(c) Conduct research into all aspects of air transport and air navigation which are of international importance, communicate the results of its research to the contracting States, and facilitate the exchange of information between contracting States on air transport and air navigation matters;

(d) Study any matters affecting the organization and operation of international air transport, including the international ownership and operation of international air services on trunk routes, and submit to the Assembly plans in relation thereto;

(e) Investigate, at the request of any contracting State, any situation which may appear to present avoidable obstacles to the development of international air navigation; and, after such investigation, issue such reports as may appear to it desirable.

CHAPTER X

THE AIR NAVIGATION COMMISSION

Article 56

Nomination and appointment of Commission

The Air Navigation Commission shall be composed of twelve members appointed by the Council from among persons nominated by contracting States. These persons shall have suitable qualifications and experience in the science and practice of aeronautics. The Council shall request all contracting States to submit nominations. The President of the Air Navigation Commission shall be appointed by the Council.

Article 57

The Air Navigation Commission shall: Duties of Commission

(a) Consider, and recommend to the Council for adoption, modifications of the Annexes to this Convention;

(b) Establish technical subcommissions on which any contracting State may be represented, if it so desires;

(c) Advise the Council concerning the collection and communication to the contracting States of all information which it considers necessary and useful for the advancement of air navigation.

CHAPTER XI

PERSONNEL

Article 58

Subject to any rules laid down by the Assembly and to the provisions of this Convention, the Council shall determine the method of appointment and of termination of appointment, the training, and the salaries, allowances, and conditions of service of the Secretary General and other personnel of the Organization, and may employ or make use of the services of nationals of any contracting State. Appointment of personnel

Article 59

The President of the Council, the Secretary General, and other personnel shall not seek or receive instructions in regard to the discharge of their responsibilities from any authority external to the Organization. Each contracting State undertakes fully to respect the international character of the responsibilities of the personnel and not to seek to influence any of its nationals in the discharge of their responsibilities. International character of personnel

Article 60

Each contracting State undertakes, so far as possible under its constitutional procedure, to accord to the President of the Council, the Secretary General, and the other personnel of the Organization, the immunities and privileges which are accorded to corresponding personnel of other public international organizations. If a general international agreement on the immunities and privi- Immunities and privileges of personnel

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leges of international civil servants is arrived at, the immunities and privileges accorded to the President, the Secretary General, and the other personnel of the Organization shall be the immunities and privileges accorded under that general international agreement.

Chapter XII

FINANCE

Article 61

Budget and apportionment of expenses

The Council shall submit to the Assembly an annual budget, annual statements of accounts and estimates of all receipts and expenditures. The Assembly shall vote the budget with whatever modification it sees fit to prescribe, and, with the exception of assessments under Chapter XV to States consenting thereto, shall apportion the expenses of the Organization among the contracting States on the basis which it shall from time to time determine.

Article 62

Suspension of voting power

The Assembly may suspend the voting power in the Assembly and in the Council of any contracting State that fails to discharge within a reasonable period its financial obligations to the Organization.

Article 63

Expenses of delegations and other representatives

Each contracting State shall bear the expenses of its own delegation to the Assembly and the remuneration, travel, and other expenses of any person whom it appoints to serve on the Council, and of its nominees or representatives on any subsidiary committees or commissions of the Organization.

Chapter XIII

OTHER INTERNATIONAL ARRANGEMENTS

Article 64

Security arrangements

The Organization may, with respect to air matters within its competence directly affecting world security, by vote of the Assembly enter into appropriate arrangements with any general organization set up by the nations of the world to preserve peace.

Article 65

The Council, on behalf of the Organization, may enter into agreements with other international bodies for the maintenance of common services and for common arrangements concerning personnel and, with the approval of the Assembly, may enter into such other arrangements as may facilitate the work of the Organization. **Arrangements with other international bodies**

Article 66

(a) The Organization shall also carry out the functions placed upon it by the International Air Services Transit Agreement and by the International Air Transport Agreement drawn up at Chicago on December 7, 1944, in accordance with the terms and conditions therein set forth. **Functions relating to other agreements**

(b) Members of the Assembly and the Council who have not accepted the International Air Services Transit Agreement or the International Air Transport Agreement drawn up at Chicago on December 7, 1944 shall not have the right to vote on any questions referred to the Assembly or Council under the provisions of the relevant Agreement.

PART III. INTERNATIONAL AIR TRANSPORT

CHAPTER XIV

INFORMATION AND REPORTS

Article 67

Each contracting State undertakes that its international airlines shall, in accordance with requirements laid down by the Council, file with the Council traffic reports, cost statistics and financial statements showing among other things all receipts and the sources thereof. **File reports with Council**

CHAPTER XV

AIRPORTS AND OTHER AIR NAVIGATION FACILITIES

Article 68

Each contracting State may, subject to the provisions of this Convention, designate the route to be followed within its territory by any international air service and the airports which any such service may use. **Designation of routes and airports**

Article 69

Improvement of air navigation facilities

If the Council is of the opinion that the airports or other air navigation facilities, including radio and meteorological services, of a contracting State are not reasonably adequate for the safe, regular, efficient, and economical operation of international air services, present or contemplated, the Council shall consult with the State directly concerned, and other States affected, with a view to finding means by which the situation may be remedied, and may make recommendations for that purpose. No contracting State shall be guilty of an infraction of this Convention if it fails to carry out these recommendations.

Article 70

Financing of air navigation facilities

A contracting State, in the circumstances arising under the provisions of Article 69, may conclude an arrangement with the Council for giving effect to such recommendations. The State may elect to bear all of the costs involved in any such arrangement. If the State does not so elect, the Council may agree, at the request of the State, to provide for all or a portion of the costs.

Article 71

Provision and maintenance of facilities by Council

If a contracting State so requests, the Council may agree to provide, man, maintain, and administer any or all of the airports and other air navigation facilities, including radio and meteorological services, required in its territory for the safe, regular, efficient and economical operation of the international air services of the other contracting States, and may specify just and reasonable charges for the use of the facilities provided.

Article 72

Acquisition or use of land

Where land is needed for facilities financed in whole or in part by the Council at the request of a contracting State, that State shall either provide the land itself, retaining title if it wishes, or facilitate the use of the land by the Council on just and reasonable terms and in accordance with the laws of the State concerned.

Article 73

Expenditure and assessment of funds

Within the limit of the funds which may be made available to it by the Assembly under Chapter XII, the Council may make current expenditures for the purposes

of this Chapter from the general funds of the Organization. The Council shall assess the capital funds required for the purposes of this Chapter in previously agreed proportions over a reasonable period of time to the contracting States consenting thereto whose airlines use the facilities. The Council may also assess to States that consent any working funds that are required.

Article 74

When the Council, at the request of a contracting State, advances funds or provides airports or other facilities in whole or in part, the arrangement may provide, with the consent of that State, for technical assistance in the supervision and operation of the airports and other facilities, and for the payment, from the revenues derived from the operation of the airports and other facilities, of the operating expenses of the airports and the other facilities, and of interest and amortization charges. Technical assistance and utilization of revenues

Article 75

A contracting State may at any time discharge any obligation into which it has entered under Article 70, and take over airports and other facilities which the Council has provided in its territory pursuant to the provisions of Articles 71 and 72, by paying to the Council an amount which in the opinion of the Council is reasonable in the circumstances. If the State considers that the amount fixed by the Council is unreasonable it may appeal to the Assembly against the decision of the Council and the Assembly may confirm or amend the decision of the Council. Taking over of facilities from Council

Article 76

Funds obtained by the Council through reimbursement under Article 75 and from receipts of interest and amortization payments under Article 74 shall, in the case of advances originally financed by States under Article 73, be returned to the States which were originally assessed in the proportion of their assessments, as determined by the Council. Return of funds

CHAPTER XVI

JOINT OPERATING ORGANIZATIONS AND POOLED SERVICES

Article 77

Joint operating organizations permitted

Nothing in this Convention shall prevent two or more contracting States from constituting joint air transport operating organizations or international operating agencies and from pooling their air services on any routes or in any regions, but such organizations or agencies and such pooled services shall be subject to all the provisions of this Convention, including those relating to the registration of agreements with the Council. The Council shall determine in what manner the provisions of this Convention relating to nationality of aircraft shall apply to aircraft operated by international operating agencies.

Article 78

Function of Council

The Council may suggest to contracting States concerned that they form joint organizations to operate air services on any routes or in any regions.

Article 79

Participation in operating organizations

A State may participate in joint operating organizations or in pooling arrangements, either through its government or through an airline company or companies designated by its government. The companies may, at the sole discretion of the State concerned, be state-owned or partly state-owned or privately owned.

PART IV. FINAL PROVISIONS

CHAPTER XVII

OTHER AERONAUTICAL AGREEMENTS AND ARRANGEMENTS

Article 80

Paris and Habana Conventions

Each contracting State undertakes, immediately upon the coming into force of this Convention, to give notice of denunciation of the Convention relating to the Regulation of Aerial Navigation signed at Paris on October 13, 1919 or the Convention on Commercial Aviation signed at Habana on February 20, 1928, if it is a party to either. As between contracting States, this Convention super-

sedes the Conventions of Paris and Habana previously referred to.

Article 81

Registration of existing agreements

All aeronautical agreements which are in existence on the coming into force of this Convention, and which are between a contracting State and any other State or between an airline of a contracting State and any other State or the airline of any other State, shall be forthwith registered with the Council.

Article 82

Abrogation of inconsistent arrangements

The contracting States accept this Convention as abrogating all obligations and understandings between them which are inconsistent with its terms, and undertake not to enter into any such obligations and understandings. A contracting State which, before becoming a member of the Organization has undertaken any obligations toward a non-contracting State or a national of a contracting State or of a non-contracting State inconsistent with the terms of this Convention, shall take immediate steps to procure its release from the obligations. If an airline of any contracting State has entered into any such inconsistent obligations, the State of which it is a national shall use its best efforts to secure their termination forthwith and shall in any event cause them to be terminated as soon as such action can lawfully be taken after the coming into force of this Convention.

Article 83

Registration of new arrangements

Subject to the provisions of the preceding Article, any contracting State may make arrangements not inconsistent with the provisions of this Convention. Any such arrangement shall be forthwith registered with the Council, which shall make it public as soon as possible.

CHAPTER XVIII

DISPUTES AND DEFAULT

Article 84

Settlement of disputes

If any disagreement between two or more contracting States relating to the interpretation or application of this Convention and its Annexes cannot be settled by negotiation, it shall, on the application of any State concerned in the disagreement, be decided by the Council. No

member of the Council shall vote in the consideration by the Council of any dispute to which it is a party. Any contracting State may, subject to Article 85, appeal from the decision of the Council to an *ad hoc* arbitral tribunal agreed upon with the other parties to the dispute or to the Permanent Court of International Justice. Any such appeal shall be notified to the Council within sixty days of receipt of notification of the decision of the Council.

Article 85

Arbitration procedure

If any contracting State party to a dispute in which the decision of the Council is under appeal has not accepted the Statute of the Permanent Court of International Justice and the contracting States parties to the dispute cannot agree on the choice of the arbitral tribunal, each of the contracting States parties to the dispute shall name a single arbitrator who shall name an umpire. If either contracting State party to the dispute fails to name an arbitrator within a period of three months from the date of the appeal, an arbitrator shall be named on behalf of that State by the President of the Council from a list of qualified and available persons maintained by the Council. If, within thirty days, the arbitrators cannot agree on an umpire, the President of the Council shall designate an umpire from the list previously referred to. The arbitrators and the umpire shall then jointly constitute an arbitral tribunal. Any arbitral tribunal established under this or the preceding Article shall settle its own procedure and give its decisions by majority vote, provided that the Council may determine procedural questions in the event of any delay which in the opinion of the Council is excessive.

Article 86

Appeals

Unless the Council decides otherwise, any decision by the Council on whether an international airline is operating in conformity with the provisions of this Convention shall remain in effect unless reversed on appeal. On any other matter, decisions of the Council shall, if appealed from, be suspended until the appeal is decided. The decisions of the Permanent Court of International Justice and of an arbitral tribunal shall be final and binding.

Article 87 .

Each contracting State undertakes not to allow the operation of an airline of a contracting State through the airspace above its territory if the Council has decided that the airline concerned is not conforming to a final decision rendered in accordance with the previous Article.

Penalty for non-conformity of airline

Article 88

The Assembly shall suspend the voting power in the Assembly and in the Council of any contracting State that is found in default under the provisions of this Chapter.

Penalty for non-conformity by State

CHAPTER XIX

WAR

Article 89

In case of war, the provisions of this Convention shall not affect the freedom of action of any of the contracting States affected, whether as belligerents or as neutrals. The same principle shall apply in the case of any contracting State which declares a state of national emergency and notifies the fact to the Council.

War and emergency conditions

CHAPTER XX

ANNEXES

Article 90

(a) The adoption by the Council of the Annexes described in Article 54, subparagraph (1), shall require the vote of two-thirds of the Council at a meeting called for that purpose and shall then be submitted by the Council to each contracting State. Any such Annex or any amendment of an Annex shall become effective within three months after its submission to the contracting States or at the end of such longer period of time as the Council may prescribe, unless in the meantime a majority of the contracting States register their disapproval with the Council.

Adoption and amendment of Annexes

(b) The Council shall immediately notify all contracting States of the coming into force of any Annex or amendment thereto.

Chapter XXI

RATIFICATIONS, ADHERENCES, AMENDMENTS, AND DENUNCIATIONS

Article 91

Ratification of Convention

(a) This Convention shall be subject to ratification by the signatory States. The instruments of ratification shall be deposited in the archives of the Government of the United States of America, which shall give notice of the date of the deposit to each of the signatory and adhering States.

(b) As soon as this Convention has been ratified or adhered to by twenty-six States it shall come into force between them on the thirtieth day after deposit of the twenty-sixth instrument. It shall come into force for each State ratifying thereafter on the thirtieth day after the deposit of its instrument of ratification.

(c) It shall be the duty of the Government of the United States of America to notify the government of each of the signatory and adhering States of the date on which this Convention comes into force.

Article 92

Adherence to Convention

(a) This Convention shall be open for adherence by members of the United Nations and States associated with them, and States which remained neutral during the present world conflict.

(b) Adherence shall be effected by a notification addressed to the Government of the United States of America and shall take effect as from the thirtieth day from the receipt of the notification by the Government of the United States of America, which shall notify all the contracting States.

Article 93

Admission of other States

States other than those provided for in Articles 91 and 92(a) may, subject to approval by any general international organization set up by the nations of the world to preserve peace, be admitted to participation in this Convention by means of a four-fifths vote of the Assembly and on such conditions as the Assembly may prescribe: provided that in each case the assent of any State invaded or attacked during the present war by the State seeking admission shall be necessary.

Article 94

(a) Any proposed amendment to this Convention must be approved by a two-thirds vote of the Assembly and shall then come into force in respect of States which have ratified such amendment when ratified by the number of contracting States specified by the Assembly. The number so specified shall not be less than two-thirds of the total number of contracting States.

Amendment of Convention

(b) If in its opinion the amendment is of such a nature as to justify this course, the Assembly in its resolution recommending adoption may provide that any State which has not ratified within a specified period after the amendment has come into force shall thereupon cease to be a member of the Organization and a party to the Convention.

Article 95

(a) Any contracting State may give notice of denunciation of this Convention three years after its coming into effect by notification addressed to the Government of the United States of America, which shall at once inform each of the contracting States.

Denunciation of Convention

(b) Denunciation shall take effect one year from the date of the receipt of the notification and shall operate only as regards the State effecting the denunciation.

Chapter XXII

DEFINITIONS

Article 96

For the purpose of this Convention the expression:

(a) "Air service" means any scheduled air service performed by aircraft for the public transport of passengers, mail or cargo.

(b) "International air service" means an air service which passes through the air space over the territory of more than one State.

(c) "Airline" means any air transport enterprise offering or operating an international air service.

(d) "Stop for non-traffic purposes" means a landing for any purpose other than taking on or discharging passengers, cargo or mail.

ANNEXES TO THE CONVENTION

1. Personnel licensing	Licensing of operating and maintenance personnel.
2 Rules of the air	Rules relating to visual and instrument flight.
3. Meteorology	Codes, meteorological communications, and meteorological services
4. Aeronautical charts	Standardization of charts for use in international aviation
5 Dimensional units to be used in air-ground communications.	Reduction in the variety of dimensional systems.
6 Operation of aircraft international commercial air services	Specifications which will insure in similar operations throughout the world a level of safety above a prescribed minimum.
7. Aircraft nationality and registration marks	Requirements for registration and identification of aircraft.
8 Airworthiness of aircraft	Certification and inspection of aircraft according to uniform procedures.
9. Facilitation	Simplification of the formalities involved in moving an aircraft, its passengers, and its cargo across international boundaries.
10. Aeronautical telecommunications.	Standardization of communications systems and radio air navigation aids.
11. Air traffic services	Establishment and operation of air traffic control, flight information, and alerting services.
12 Search and rescue	Organization of facilities and services necessary for search and rescue.
13 Aircraft accident inquiry	Uniformity in the notification, investigation of, and reporting on aircraft accidents.
14. Aerodromes	Characteristics and equipment for aerodromes used in international navigation.
15. Aeronautical information services	Uniformity in methods of collection and dissemination of aeronautical information

(Whereupon, at 1:30 p m., the committee adjourned to reconvene at 2:30 of the same day.)

AFTERNOON SESSION

(The committee reconvened at 2:38 p. m., Hon. John W. McCormack, presiding.)

The CHAIRMAN. The first witness will be our former colleague and friend, the Honorable Harris Ellsworth, Chairman of the Civil Service Commission. Harris, we are glad to see you here and welcome you back among us.

STATEMENT OF HARRIS ELLSWORTH,[40] CHAIRMAN, UNITED STATES CIVIL SERVICE COMMISSION; ACCOMPANIED BY WARREN B. IRONS, EXECUTIVE DIRECTOR, UNITED STATES CIVIL SERVICE COMMISSION

Mr. ELLSWORTH. Thank you, John. It is a pleasure to be up here before this great committee. I hope I can contribute something worthwhile.

I have a rather brief statement, Mr. Chairman.

I appreciate being given the opportunity to comment before this committee on H. R. 11881, establishing the National Aeronautics and Space Agency. This is indeed a fast-moving age. When I was a Member of the Congress, I did not have the opportunity to consider legislation for such a thought-provoking subject as research into problems of flight within and outside the earth's atmosphere

My special concern, and I am sure your interest in my testimony, bears on section 6 (b) (2) of the bill which exempts the new Agency from the Classification Act of 1949 and the Federal Employees Pay Act.

It gives the proposed NASA authority to—

> fix and adjust, as nearly as consistent with the public interest and on the basis of equal pay for equal work at rates which are reasonably comparable with prevailing rates paid by non-Federal employers for similar work, compensation of such officers and employees as may be necessary to carry out the provisions of this Act.

This authority would be subject to such regulations as the President might prescribe.

I am sure that you have already been presented with ample evidence of the special and critical requirements of this most important activity to attract and retain the country's most outstanding personnel in order to continue and expand the research activity in this vital area When considering the personnel problems involved in staffing the agency which H. R. 11881 would create, two important and compelling facts must be borne in mind.

First, this Agency occupies a position of the highest possible importance in Government operations and will deal with some problems the solution of which lie as yet outside the knowledge and experience of man.

Second, there is a decided element of urgency in the mission of this proposed Agency—certainly this Agency must function with speed, accuracy, and efficiency, and must be as free from staffing problems and personnel difficulties as possible.

In view of these facts the NASA must be able to adjust promptly and adequately to competitive salary rates in order to maintain an adequate and qualified work force for the support of this important mission.

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[40] Ellsworth, Harris (ĕls'wûrth), b Hoquiam, Wash , Sept 17, 1899, s Elmer Elbridge and Eva Catherine (Forbes) E , B S , U of Ore , 1922, m Helen Evangeline Dougherty, June 21, 1923, children—Mary Margaret, Patricia Jane Advertising manager, Eugene (Ore) Register, 1922, in lumber business, 1923–25, manager 4-L Lumber News, 1926–28, Ore State Editorial Assn , 1928, editor, manager, part owner, Roseburg (Ore.) daily News-Review, and radio station KRNR Member 78th–84th Congresses from 4th Ore. Dist. Pvt , S A T C , World War I Apptd mem Ore State Senate, 1941 session Mem Ore Ednl Commn , U of Ore Alumni Assn (former pres), Ore Newspaper Pubs Assn , Chamber Commerce, Red Cross, Am. Legion, The Grange, Kappa Sigma, Sigma Delta Chi, Sigma Upsilon, Phi Mu Alpha Republican Episcopalian Elk, Eagle Clubs Rotary, Country (Roseburg, Ore) Home Roseburg, Ore. Office Washington, D C

The proposed pay provisions in this bill are intended to meet this need for timely and adequate pay adjustment. These provisions include at least two desirable restrictions. One calls for a welding of the principle of equal pay for equal work with the principle of reasonable comparability with prevailing pay. This will effectively guard internal job and pay alinement against undesirable dislocations.

The other requires that this authority be exercised under regulations prescribed by the President. This will assure that this authority will be exercised subject to externally imposed standards, and I believe we may presume that such standards will require the administration of this authority to be geared properly with relevant existing practices and procedures of pay fixing in the Government.

For example, it is my understanding the Agency, even though exempt from the position classification provisions of the Classification Act, will nevertheless continue to classify its jobs in a manner fully consistent with job classification under the act, so that there will be no obscurity as to occupational classification and grade level allocation as between the positions in the NASA and positions which are subject to the Classification Act.

Moreover, it is my understanding that no additional organization will be established by this Agency to obtain the necessary field data on pay rates paid by non-Federal employers but instead will be able to rely on existing data collection organizations.

The principle of fixing rates of pay which compare reasonably with current compensation of non-Federal employees engaged in broadly comparable work is not new. I understand the NACA currently has nearly half its employees already compensated under a prevailing rate system with which it has had many years of experience.

This experience augurs well for the successful extension of this principle to the additional categories of positions which this legislation will authorize. The agency in all respects except pay, that is to say except for the exemption from the Classification Act and the Federal Employees' Pay Act of 1945, will be subject to all of the civil service and personnel control laws which presently apply to the NACA.

In view of the special circumstances of this new Space Agency I am convinced that special provisions for the establishment of pay rates such as have been proposed are fully warranted. With the emphasis that has been given to the principles of equal pay for equal work and other controlling principles we are confident that this pay plan can operate successfully. This departure from the somewhat traditional rigid provisions of the Classification Act pay structure is wholly justified and should permit the needed flexibility and responsiveness to prevailing pay practices which will be so essential for the successful operation of this uniquely new program.

I do not wish to imply that adoption of the proposal for NASA will solve the problems of other agencies. The Congress may soon have to face the problems of other agencies engaged in critical developmental activities such as the great research enterprises in the Department of Defense and many of those in other long-established agencies which do not have the proposed authority.

It has seemed to me for some time that the way in which the Government establishes the rates of pay for most of its white-collar workers is antiquated and hardly compatible with this space age. The

efforts to meet the Government's salary needs by the establishment of rigid statutory pay scales for Classification Act and postal employees, and the difficulties that this imposes upon both the legislative and executive branches are very well known.

The pay system proposed in H. R. 11881 represents a different approach than heretofore made toward a relief from the difficulties and headaches connected with the present basis of setting most Government salaries by statute. Even though in itself this experiment may create new and different personnel management headaches it would seem to be a step worth taking; an experiment that should be made and, which I might add, being experimental, is quite in keeping with other objectives of this proposed legislation.

I am convinced that the authority proposed for NASA in section 6 (b) (2) of H. R. 11881 will provide a pilot operation in the personnel field which may help materially our efforts to develop a better way of setting salaries.

I urge its adoption.

That concludes my statement, Mr. Chairman.

The CHAIRMAN. Mr. Ellsworth, on page 4, the second paragraph of your statement, you present a troublesome question that confronts some of the members of the committee.

I am for the provision of the bill contained on page 6, but what concerns me is what will be its relative effect elsewhere upon those scientists and technicians in other departments and agencies who are under, or who are subject to the Classification Act?

Mr. ELLSWORTH. Well, I think, Mr. Chairman, that the effect would be rather more in a morale way than actual. Because I am told by the NASA people—or I mean the NACA people—informally that this new Agency would probably not involve the employment of more than 200 more people.

In other words, an infinitesimal number compared with the Government as a whole.

So I doubt that this provision would actually set up anything in the way of competition as between this new Agency and the other important agencies.

However, there will be that feeling, I think, and it is only natural, because it exists with respect to the other excepted services to some extent, that these Agency people are better treated than the ones in the other agencies.

It doesn't necessarily follow that that is true. But there will be that thought, I think.

The CHAIRMAN. Will the provisions of paragraph 2 of section 6 cover all of the employees of this new Agency when established?

Mr. ELLSWORTH. It is my understanding that it does.

The CHAIRMAN. Clerical help and all others?

Mr. ELLSWORTH. Yes. It covers all employees of the Agency.

The CHAIRMAN. Of course, from the angle of relative effect, if a scientist or technician working in the Defense Department under the Classification Act, whose salary is less than what one of the same positions that would be under this Agency—and you can include other agencies where scientists and technicians are employed—I am wondering how he would feel under those circumstances.

Mr. ELLSWORTH. Well, Mr. Chairman, that is one of the minor risks. I should point out that there is another situation in Public Law 313 which gives to five agencies presently the——

The CHAIRMAN What is that citation?

Mr ELLSWORTH. Public Law 313.

Mr FULTON. What year?

Mr ELLSWORTH. We will have to furnish you the precise citation. I don't have it here

In the parlance of the trade, so to speak, we refer to these positions as 313 positions. That law allows the five agencies which have the benefit of it to employ people in scientific—employ people in research and development fields, I believe it is.

It is narrowly defined. Employ them at salaries ranging from $12,500 up to $19,000, on the basis of the individual.

In other words, they have to send to the Commission the qualification statement for the individual and the proposed salary. And then our technical people examine the qualifications and see if the request is otherwise in order

Now, that is really a very similar thing to this under a different name.

The CHAIRMAN. You can see the matter that concerns me. I would go right across the board. But we don't have the jurisdictional authority to do that. That is a matter which should come before the Committee on Post Office and Civil Service. But that is a matter of concern.

The provisions themselves don't concern me. But I then ask, what will be the effect of unintentional inequity on others?

Mr. ELLSWORTH. As I pointed out in my prepared statement, we at the Commission, are aware that big Government having come to stay, something should be done legislatively to change the present basis for setting rates of pay by statute.

I think we are seeing at this moment the problems that are involved in the present way of doing it.

The pay bills have been pending now in the Congress for two sessions, a lot of time being used in debate on them, with the possibility that there will have to be more discussion of the same subject next year.

I mean that is a possibility. We think that there must be a more practical and more efficient way of doing it.

So this may point a way in that direction.

The CHAIRMAN. You say the other five agencies have the authority on individual cases to go ahead——

Mr. ELLSWORTH They have very limited authority. I think with reference to defense itself the number probably is 25. I think the Department of Agriculture is allowed five of these appointments. The Institute of Public Health is allowed a certain number. They are all by statute

In other words, only five agencies have this authority. And none of the five have any more than just a few that they may allocate in this category

However, it is a precedent and it is a principle presently in use.

The CHAIRMAN. But this would be a precedent over that. You say it would cover employees in the clerical status, for instance. Suppose this provision went through. What could this Agency do in connection with their salary, subject to such regulations as the President may prescribe, without regard to the Classification Act of 1949 as amended?

Mr. ELLSWORTH. Well, it is still to be determined, of course. I would assume that the regulations and grade lists and salaries set up by the new Agency under this new authority would follow the Bureau of Labor figures and the prevailing rates in the various communities where they operate. I think that is what is intended by the section.

The CHAIRMAN. Of course in the Navy Department you have some such situation existing in relation to certain employees in connection with the prevailing wages as it applies to industry. But this is different than that, I think. Isn't it?

Mr. ELLSWORTH. A third of the employees of Government, about 750,000, are now working under the prevailing rate plan, under what we call the wage board or blue-collar principle. They are now limited to crafts, trades, and common labor. Their rates of pay, their hourly rates generally, are set by local boards on the basis of surveys conducted locally. They represent about a third of all the workers in the Government.

In NACA presently are employed 3,535 of these prevailing rate blue-collar employees, and 4,230 of their employees are under the Classification Act. So the NACA has considerable experience with the prevailing rate type of employment.

The CHAIRMAN. You say the pay system proposed in H. R. 11881 represents a different approach than heretofore made to afford relief from the difficulties and headaches connected with the present basis of setting most governmental salaries by statute.

So, for this agency we have an entirely different approach than the rest of the governmental agencies, with the possible exception of these isolated cases you have mentioned on a case-to-case or individual-to individual basis in the field of science and technology.

Mr. ELLSWORTH. It is a different kind of exception. Now, we have, I think, about 40 different pay systems in Government; 40 different other exceptions to the terms of the Classification Act.

This, however—this approach is different from any of the other 40, and the reason that I have—or one of the main reasons why I have testified in favor of it is that this is the first time, if this is enacted, wherein what we call white collar or classification type people will be employed under a prevailing rate pay system.

And as I said in my statement, it is something that we think probably is well worth trying. It has never been done before.

The CHAIRMAN. You say under the present rate of pay system the words—

> on the basis of equal pay for equal work at rates which are equally comparable to the prevailing rates paid by non-Federal employees for similar work

Well, under this your stenographic employees might get a reduction in salary.

Mr. ELLSWORTH. That could be possible.

The CHAIRMAN. Now, many of your clerical help could get a reduciton in salary.

Mr. ELLSWORTH. This gives the agency complete freedom under the rules set up.

The CHAIRMAN. But they have to do it on the basis of equal pay for equal work at rates which are reasonably comparable with prevailing rates paid to non-Federal employees of similar work. They have got to comply with those provisions?

Mr. ELLSWORTH. Yes. The reference is to the competition with industry or with non-Federal employment in the different areas.

The CHAIRMAN. Taking the city of Washington, are the stenographers in Government paid more than those in nongovernment service?

Mr. ELLSWORTH. I don't know.

The CHAIRMAN. I should think they would be.

Mr. ELLSWORTH. The rates for the same job are the same the Nation over. But I wouldn't be surprised but what in some communities a grade 3 typist is probably paid more than a similar typist in non-Federal employment. But I am sure there are other places where she is not paid as much.

A nationwide statutory salary does have some inequities in it, no matter what we do. That is one reason we are interested in this experiment; to see if there is a better way.

The CHAIRMAN. Well, of course we are confining it to this agency. But you have indicated it might well be a pattern for a good part of the Government. And then you have got to project your mind and see what the results of that might be.

Mr. ELLSWORTH. My own thinking on that is that it may give us—if this is enacted and this agency does operate under this section, that it will give us some awfully useful field data on which a broader plan or policy could be set up.

At the present time we don't actually have any pilot or experimental data on which to base a proposed change. I think that is one of the reasons why we haven't come up with a suggestion for a better system.

The CHAIRMAN. I know. But we are going to have a fundamental change like that. You have been a Member of Congress for years, and you know the jurisdiction of committees. Don't you think that is a matter that should be taken up with the proper committees, such as the Post Office and Civil Service?

Mr. ELLSWORTH. That is right.

The CHAIRMAN. And if we were to report this provision out, much as I might be impressed with it, I refer to my previous statement in connection with scientists and technicians—the technical men. I hadn't thought of the clerical and stenographic force until I asked you the question that they might even get a reduced salary under this.

Mr. ELLSWORTH. Well, you can't tell. It just depends on what their survey reveals.

The CHAIRMAN. But nobody wants that.

Mr. ELLSWORTH. Actually my thinking with reference to the subject generally is in the broad sense. And obviously that should go to the legislative committees. This is an exceptional thing, and it is something that is brandnew. I think your committee has every right in this case to specify just exactly how it should be done.

The CHAIRMAN. Of course, we are making really a fundamental change. And it is not something that is sort of an experiment to determine whether it should be applicable right across the board.

Mr. ELLSWORTH. We could find out—if this is done, just how it does work in actual practice.

The CHAIRMAN. You say that there are provisions of law where in other agencies they can, on an individual case, take up with the Civil Service Commission and with the approval of the Civil Service Com-

mission bring about a result which is, in effect, a waiver of the Classification Act—pay a higher wage?

Mr. Ellsworth. That is right.

Those are for technical people.

The Chairman. I assumed that this is intended more or less for technical people.

Mr. Ellsworth. Of course that authority we are speaking of now, that 313 authority, doesn't go to typists or jobs of that kind. They are a very narrowly defined group of people.

The Chairman. I doubt that the many tens of thousands of persons employed in clerical positions, stenographic positions, in the postal service and all other services—I don't know how they would feel about this, because it is really a fundamental change while confined to one agency.

When I was asking you about the relativity, I was confining it to scientists and technicians and by "technicians" I mean scientists in the applied sense, and others in the technical field. But this was intended to enable the government agencies to keep those men and to induce them to stay on.

But this legislation might give them a preferential status where they might go out and raid other agencies. Not that they would, but the situation would exist where scientists and others who come under this provision might seek to get into this new agency because of the higher salary.

Mr. Ellsworth. They might. But as I pointed out earlier it isn't likely this agency is going to be very competitive with any other agency, because it is already in business, and they don't expect to hire very many more.

The Chairman. There must be some incentive for them to have this provision—it must be a competitiveness between the other agencies—that is, the move on the part of the agency to try to keep men in the service of the agency.

Although the scientists and technicians may not get as much as a private employer might give them, there are many dedicated men in the country.

Yet, on the other hand even dedicated people have to consider the economic situation for themselves and their families. We all have to. That is a natural, legitimate, selfish consideration—justifiably selfish; not unjustifiable. It is consistent with theology—justifiable selfishness.

Would you submit to the committee the language of the 313, so that the committee might consider it?

Mr. Ellsworth. Yes.

The Chairman. And in connection with the technicians, I am not saying how I would vote on it, but I see these dangers. And I see a bill that has a very desirable objective getting on the floor. It might get tangled up in that jurisdictional dispute. And other groups of Federal employees might get alarmed at it. And I couldn't criticize them. I am not prepared to say whether I could criticize them.

But I wouldn't want to have a bill, with such desirable and necessary objectives, become tied up in a journey through Congress by something that is really minor in its nature and which should be approached from a broader angle.

Mr. ELLSWORTH. We will be glad to supply the information requested.

The CHAIRMAN. I would like to have you submit it on 313. . And if in connection with scientists and technicians you can liberalize 313 to this agency so far as the Civil Service is concerned, it would be appreciated.

I never thought for an instance that this was intended to go into the clerical element, what might be termed "clerical help." I can see under that——

Mr. ELLSWORTH. It applies to all——

The CHAIRMAN. It might reduce the salary.

Mr. ELLSWORTH. The terms of the section do apply to all employees of the agency.

The CHAIRMAN. You have been very helpful. Other members of the committee will ask you questions.

But this particular paragraph of the bill is what concerns me in its relationship to other agencies. And our other colloquy has come from additional information that I was not consciously aware of.

Mr. ELLSWORTH. We think of it as a very interesting and rather useful proposal.

Mr. McDONOUGH. Would the chairman yield at that point.

The CHAIRMAN. Yes.

Mr. McDONOUGH. Could that be overcome by a minimum wage under a specification for the type of position?

Now, I can anticipate the white collar employee and some of the blue collar employees in this agency being employed for a minimum wage and for a specific reason because they have a certain capability. And if the specification were written and the minimum wage rate, there would be no reduction.

Mr. ELLSWORTH. I am going to ask Mr Irons to respond to that. He is the Executive Director of the Commission.

Mr. IRONS. This provision of course would apply with a prospective hiring primarily, not to people on the rolls at the present time. If we had a Classification Act person on the rolls, his current rate would be protected by existing law; no special language is needed for that purpose

The CHAIRMAN. But supposing somebody is hired after this bill becomes effective, and he is hired as a clerical employee, and he gets less salary than somebody else in the same position.

Mr. IRONS I would think that would present an interesting problem moralewise for the agency.

The CHAIRMAN. It could be, under this.

Mr. IRONS We will be glad to supply the language on the Public Law 313. We will have it up here tomorrow morning.

The CHAIRMAN. Mr. Hays.

Mr. HAYS. I have no questions. I do want to say to our old friend and colleague that we are delighted to have him here and I am glad he can cross over that bridge that separates the legislative and executive department.

Mr. ELLSWORTH. Thank you.

Mr. HAYS. I am pleased to know that you attach a great deal of importance to personnel standards in this procedure.

Mr. ELLSWORTH. It is fundamental I think in our whole personnel-management problem.

Mr. HAYS. Thank you.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. I have no questions. But I want to join with you in thanking our former colleague, Mr. Ellsworth, for his appearance.

Mr. SISK. I think all the questions I had were brought out.

Mr. McDONOUGH. I just want to greet my former colleague. I appreciate your point of agreeing with the committee that this is a specialized agency and does require special treatment.

Mr. ELLSWORTH. Nothing like this has ever been contemplated before. And I think it is entitled to have that type of consideration by Congress.

The CHAIRMAN. Have you consulted with the Civil Service Commission?

Mr. ELLSWORTH. We consulted.

The CHAIRMAN. Were you in on the actual drafting?

Mr. ELLSWORTH. I don't know whether we had any part of setting up the words or not. But we knew what was being put in it.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. No questions. We are glad to have you here. I think you have given an excellent statement. I think that some of your words should be pointed out especially, because I think they are particularly appropriate in this time when the country and Congress is looking which way to go.

You have said:

> Ample evidence of the special and critical requirements of this most important activity.

And further:

> To attract and retain the country's most outstanding personnel in order to continue and expand the research activity in this vital area.

I like those statements very much.

On page 2 you have also stated very well—

> Secondly, there is a decided element of urgency in the mission of this proposed agency. Certainly this agency must function with speed, accuracy, and efficiency and must be as free from staffing problems and personnel difficulties as possible.

I agree with those thoroughly and believe that we are in a vast new field, that we should keep our minds open and be willing, in Congress, to meet the challenges as they come up.

Thank you, very much.

Mr. ELLSWORTH. Thank you.

The CHAIRMAN. Mr. Ford?

Mr. FORD. Mr. Chairman, our former colleague has presented a very fine justification, I think, of the proposed provision. I think you have covered the points where there might be some area of modification, perhaps. We are glad to have Mr. Ellsworth with us on this occasion. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Feldman? Mr. Feldman is our director and general counsel, Harris.

Mr. FELDMAN. In addressing ourselves to this particular section, I see no ceiling in here; no limitation of any kind on wages.

Mr. ELLSWORTH. The limitation in the section, of course, is the prevailing rate of the competition—the reasonable competition of non-Federal employment, I think.

Mr. FELDMAN. How do you envisage that that will be determined?

Mr. ELLSWORTH. I don't know that any actual plan has been made on it. But I think it was assumed in discussing it in the preliminary stages that the Bureau of Labor Statistics service would probably be used.

Mr. IRONS. If I might answer that a little more specifically. It is my understanding of the preliminary thinking on the plans, if this section is passed by Congress, that the NASA would request the Bureau of Labor Statistics to conduct rate studies in the various localities and nationwide for the occupations and professions in which they are interested. In turn, based upon that information, the Director of the NASA would make such recommendations to the President or whatever agency is designated by the President as to what he thinks the rate should be based upon the prevailing rate data.

Also that the Director of the NASA would make certain that the various positions in NASA would be related to like positions under the Classification Act.

Mr. FELDMAN. That is the modus operandi.

Mr. IRONS. That is the plan of thinking.

Mr. FELDMAN. The modus operandi.

Mr. IRONS. That is correct.

Mr. FELDMAN. Could that be narrowed so that in the case of a dispute the President could look to the Civil Service Commission for its views on the subject?

Mr. IRONS. It is my understanding at this time that no decision has been made yet as to what agency of the Government the President would rely for disputes of that nature and for determining whether the Director of NASA was carrying out his responsibilities correctly.

It would be my judgment—and I will admit that I have a certain bias in this direction—that the logical agency to perform that function would be the Civil Service Commission.

We have the know-how in this particular field.

Mr. FELDMAN. And if this provision were amended in that connection, would that not be a similar safeguard?

Mr. IRONS. I don't know the legal niceities of having the legislation direct that the President shall issue regulations, or propose that the President shall designate the Civil Service Commission as the agency. I don't know that it is customary to have the President's hands tied to that extent in legislation.

Mr. FELDMAN. It could be a way, though, of curing the situation.

Mr. IRONS. Yes.

Mr. FELDMAN. Now, getting back to Public Law 313——

Mr. ELLSWORTH. I think I should point out that that illustration isn't really on point with this section. I merely used it in my comments to indicate that there had been, and is now existing——

Mr. FELDMAN. There is a technique, in other words, and the technique is found in Public Law 313.

Mr. ELLSWORTH. In general, that is correct, yes.

Mr. FELDMAN. And there may be some language in 313, again, that would be helpful in nailing down this provision and making it a lot more specific than it is at the present time. This would seem to give a great deal of latitude to fix wages at almost any scale manageable.

Mr. ELLSWORTH. There would be very definite limitations. I mean the section itself——

The CHAIRMAN. Is NACA now covered by 313?

Mr. ELLSWORTH. Yes.

It permits the employment of a particular specialist, a particular scientist or particular engineer wanted very badly by a particular agency. And this allows them that—this allows that agency up to $19,000, based upon the qualifications that he has to hire him and present to the Commission the reasons for doing it.

The CHAIRMAN. Has there been much difficulty in having the approval made by the Civil Service Commission?

Mr. ELLSWORTH. No. In general the qualification of such people has been very high——

The CHAIRMAN. It has to be somebody who is not only a scientist but particularly specialized.

Mr. IRONS. It is professional and scientific, I believe, are the terms. It has to be in research areas. And the individuals are unusually well qualified for the particular assignment. The man is related to the job.

Mr. FORD. May I ask a question, Mr. Chairman?

The CHAIRMAN. Certainly.

Mr. FORD. Under 313 and under this provision, if Congress subsequently passed legislation increasing wages for Government employees, would the people covered by this section and by 313 get a comparable automatic increase; or would their increases come by administrative action subsequently?

Mr. ELLSWORTH. Well, with reference only to 313, their increases would come only by requests from the agency to adjust their salaries.

Mr. FORD. Would the same apply to the proposed provisions?

Mr. ELLSWORTH. Under this, they would work out their own—it would be based on equal rates—as it says:

> Equal pay for equal work at rates which are reasonably comparable with prevailing rates.

That would be their authority. I want to again point out with reference to this 313, it is a very limited category and for a very specific purpose. I doubt that there would be any basis of actual interpolation of that, with this—NASA.

The CHAIRMAN. But anything we do might have an effect on agencies employing 313 employees?

Mr. ELLSWORTH. Not very much.

The CHAIRMAN. Well, I know. But there is a law of relativity that applies.

Harris, suppose there is a scientist in the Defense Department, and he is getting, say, $14,000 a year. And, under this a man of similar position and comparable ability in the NASA gets, by reason of the operation of these provisions, gets $16,500 or $17,000. That could happen, couldn't it?

What would be the views of the fellow in the Defense Department or in some other agency doing research work?

Mr. ELLSWORTH. As I said earlier, there would be a morale problem there.

It actually wouldn't be practical for the people, say, in the Defense Department to move over to the other agency, because they wouldn't need them. But nevertheless there would be that disparity, certainly.

The CHAIRMAN. In the field of scientific and technical positions, I can understand it. It may be that the equal pay for equal work might well be across the board. I don't know.

I am not passing on that.

Now, we know that in the Navy Department certain employees—mechanical and others—are subject to a law like that. And as I understand it, their pay is determined by what is paid in private employment within a reasonable area.

Mr. ELLSWORTH. That is correct.

The CHAIRMAN. Under this NASA, there is no agency. They have boards appointed. They look into it very thoroughly. I know many times the employees claim that they are not getting an increase that is comparable—equal pay.

You would have to have a board for Washington and a board for wherever they were.

Mr. IRONS. It could be on a national prevailing rate pattern, either one.

Mr. FELDMAN. The Bureau of Labor Statistics Index.

Mr. IRONS. That is right.

The CHAIRMAN. The rate of pay, say, in a laboratory out West might be different from a rate of pay in the central office in Washington

Mr. ELLSWORTH. That is quite right.

The CHAIRMAN. Now, they are all at the same salary.

Mr. IRONS. They all get the same salary now. This law as I read it would permit rates to be determined on a local prevailing rate basis or on a national prevailing rate basis; for some provisions locally.

The CHAIRMAN I ask that you draw up language based on 313. I find now in asking you some questions that that is confined to employees who are needed for a specialized position, although there may be others who are capable of doing it.

Mr. IRONS. It is very narrow.

The CHAIRMAN. I can see there where there might be the necessity for a little broadening. Would you draw up language based on 313 and a little broader language confining it to what you might call the scientific staff—scientific employees, technicians. Do you understand what I mean?

Mr. IRONS. Yes.

The CHAIRMAN. In other words here we can go beyond 313 and yet not put through a fundamental change for this Agency in the salary set up for the classified Government employees.

Mr. IRONS. Congressman, could I ask a question right now?

Who on your committee should we contact if we need to ask further questions?

The CHAIRMAN. Mr. Feldman.

Mr. IRONS. Fine. Thank you.

The CHAIRMAN. Any further questions?

Mr FELDMAN. Yes; I have one question.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. The purpose of this provision in the legislation is primarily to enable the new Agency to compete with private industry in hiring scientists and research people; is that not so?

Mr. ELLSWORTH. That is correct. I think it might go even farther than that I think they have in mind that when they start in to do something they don't want to be hampered, they want to be able to go and get the employees they want and put them to work.

Mr. FELDMAN. That is true, but I am talking about research people and scientific people. And there is testimony before this committee that all relate to that one group—in other words, the group that you say are paid a wage scale ranging between $12,000 and $19,000 a year.

Now, if this provision were restricted to that category and the rest subject to the usual civil service classification law, might that not meet the objective of those behind this legislation?

Mr. ELLSWORTH. I am not quite certain about that. What you would have then would be three different pay systems in the single Agency. You would have the wage board, the blue-collar people, about 3,500 of them already work for NACA. Then you would have the Classification Act, ordinary employees such as the clerks, typists, and supervisors. Then you would have your professional prevailing rate type of group as a third category.

Mr. FELDMAN. This new provision, which would only apply to new employees; might you not be in the situation of where a scientist would be employed who would receive a higher wage than another scientist who was already on the payroll?

Mr. IRONS. I wouldn't think so. I would think the Agency would adjust the salaries within the Agency so that they would be comparable.

Mr. FELDMAN. But you say that wouldn't apply; this particular provision wouldn't apply to those already employed.

The CHAIRMAN. As I understood it, Mr. Ford asked in case the pay-raise bill went through, would the employees benefit. You answered "no." Is that right?

Mr. IRONS. If this were law the people employed under this law would look to this law for any improvement or ——

Mr. FELDMAN. Well the language in the act says, "To select, appoint, employ, and subject to such regulations as the President may prescribe."

That "to select, appoint, and employ"—does that mean people already employed or new people?

Mr. IRONS. I would think that would mean new people to NASA.

The CHAIRMAN. That means their appointment would have to be subject to the civil-service law for examination, certification, veterans' rights, and so forth. In other words, the appointment would have to be in accordance with the civil-service law or transfers from one agency to another.

Mr. IRONS. That is the way I understand it, yes.

Mr. FELDMAN. I am directing myself to another situation. The new agency is going to take over the NACA. You stated before that this provision would not be applicable to NACA but that they would get the wage scale that they are presently obtaining; is that not so?

They have 7,600 employees or around that number. This does not affect them

Mr. IRONS. This does not affect the employees of NACA, as I see it. When NASA comes into existence, NASA would take over, I would presume, employees of NACA, the existing agency.

Mr. FELDMAN. Would they be new employees within the terms of this legislation?

Mr. IRONS. Yes.

Mr. FELDMAN. Then they would be reclassified based on this provision; all of the NASA employees?

Mr. IRONS. That is the way I would interpret this; yes.

Mr. FELDMAN. Well, that isn't the way it was explained to us in the report.

Mr. IRONS. That is the way I interpret it. I may be wrong about that.

Mr. FELDMAN. Wouldn't the objective of the provision be met if you limit this provision to apply to people engaged in scientific and research work?

Mr. IRONS. What kind of people? You mean scientific?

Mr. FELDMAN. I am talking about scientists.

Mr. IRONS. That is the Public Law 313 type of individual.

Mr. FELDMAN. That is right; just confined to those particular people. Would not the objectives of this law and the reason for this provision, in other words, be fulfilled?

Mr. IRONS. As I interpret this provision it goes far beyond that.

Mr. FELDMAN. Yes, it does. We are getting into a brand new field.

Mr. IRONS. I won't argue that with you, but I think the objective of this legislation was to give, within the limitations written here, the broadest possible authority to the Director of this new Agency to recruit and retain all kinds of people, not just research people.

Mr. FELDMAN. Then it becomes an experiment, as you say, in connection with other phases. And don't you think that that kind of legislation belongs before another committee of the Congress?

Mr. ELLSWORTH. My own feeling is that as an experimental proposition this is relatively small. And this committee could report this bill out with this provision in it on that basis; that it is something new, unusual, more or less a crash-program idea, and that this is needed to make it go.

Mr. FELDMAN. Well, the impact of it might be tremendous if the experiment was not successful.

Mr. ELLSWORTH. Well, if it is not successful, no particular harm has been done because the whole employment is so small.

Mr. FELDMAN. I wouldn't say that. It might have chain reaction to it even though it is, as you say, small. Because you have over 8,000 people employed at the present time. And that number will increase substantially.

Mr. ELLSWORTH. I notice in this section 10 (a) it refers to the liquidation of NACA, and says that the personal property and personnel et cetera are transferred.

What effect that would have on the employment, I am sure I don't know.

Mr. FELDMAN. It does raise a question as to whether or not those people presently employed under present salaries and who are scientists might not be paid a lower wage than the new scientists coming in and doing the identical work. That possibility could arise.

Mr. ELLSWORTH. I suppose, technically, but practically it wouldn't, I am sure. With this authority, they could adjust it.

The CHAIRMAN. I would like to have you prepare language, as I said, 313, and then additional language which would permit further flexibility without the strictness of 313, where it will be tied up with the Civil Service Commission approving it. In other words, the

language wouldn't necessarily have to apply on an individual basis, but might cover a group in the technical field.

Mr. IRONS. But not going as far as all employees of the Agency.

The CHAIRMAN. No. I am not saying what we will do, but I would like to have it so we can have it before the committee when we are in executive session.

Mr. IRONS. This latter one might cause us some difficulty. We might have to ask for more conversation with your counsel on that latter provision. The word "technical" is pretty broad. And just what you want the Commission to do, I am not sure I fully understand.

The CHAIRMAN. What does the Commission do in these individual cases?

Mr. IRONS. We pass on an individual-case basis.

The CHAIRMAN. I don't like to see you get too far away from the Civil Service Commission, because we know the history of the Commission. And the Commission acts with reasonable speed, as I have observed throughout the years.

In other words, outside of appointment in accordance with civil-service laws, the provisions of this bill, if enacted into law, would free this Agency from the control of the Civil Service Commission, and their obligation would be to make salaries on the basis of equal pay for equal work and so forth.

Mr. ELLSWORTH. The only thing that this section does with reference to the personnel is on the rate of pay. All the other provisions, as I understand it, of civil-service employment are left intact. It is just the pay rate that is involved in this section.

So that the civil service is not really done any particular violence by this section of the bill which exempts the new NASA from the provisions of the Classification Act. We have a lot of people in civil service who are not under the Classification Act. As I said, we have 40 different pay systems. Practically all are under the civil service, but not under the Classification Act.

The CHAIRMAN. Submit your drafts to us. You are not binding yourself by that. You are simply cooperating with the committee. You have had the years of experience in Congress, and you know how jealous committees are of jurisdiction. And I couldn't criticize if they took that position. They may not. I don't know. And I could see where a pretty interesting debate could be raised right on that particular question which might have affect upon the whole bill.

Mr. ELLSWORTH. You have an awfully tough problem here, I believe. One of the big objectives in framing this legislation is to provide as much freedom of action, and freedom of everything, for this Agency, so that it may be able to pursue its rather amazing assignment unhampered. And that is, of course, what this section of the bill is attempting to do.

The CHAIRMAN. You don't have to have freedom for a messenger. You don't have to have freedom for clerks, so far as this agency is concerned. You don't have to have freedom for stenographers. The freedom is where the progress is going to be made in this great field of unfathomable possibilities. And that is going to be among the scientists and technical employees, not disregarding the importance of the others.

But their salaries are fixed by law, just like all others are in every other agency. And I can see, under this, that scientists will benefit, get an increase, and I am for it. I am for it in other agencies. I recognize their importance. I recognize the necessity. On the other hand, if I were a clerk, I don't know whether I would want to see legislation enacted suspending the civil-service pay rate, particularly when I might get a reduced salary.

So, will you draft that language?

Mr. IRONS. Yes; we can, Mr. Chairman.

The CHAIRMAN. Any further questions?

I want to join with my colleagues, Chairman Ellsworth, in thanking you and Mr. Irons. I might also say that you are one of the best appointments, in my opinion, that President Eisenhower has made.

Mr. ELLSWORTH. Thank you very much, Mr. Chairman. That is very fine of you to say and nice for me to hear.

The CHAIRMAN. Thank you.

(The following material was filed with the committee:)

ATTACHMENT 1

PUBLIC LAW 313, 80TH CONGRESS, AUGUST 1, 1947, AS AMENDED

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That (a) the Secretary of Defense is authorized to establish and fix the compensation for not more than one hundred and twenty positions in the Department of Defense and not more than twenty-five positions in the National Security Agency, each such position being established to effectuate those research and development functions, relating to the national defense, military and naval medicine, and any and all other activities of the Department of Defense and the National Security Agency, as the case may be, which require the services of specially qualified scientific or professional personnel

(b) The Chairman of the National Advisory Committee for Aeronautics is authorized to establish and fix the compensation for, in the headquarters and research stations of the National Advisory Committee for Aeronautics, not to exceed thirty positions in the professional and scientific service, each such position being established in order to enable the National Advisory Committee for Aeronautics to secure and retain the services of specially qualified personnel necessary in the discharge of the duty of the Committee to supervise and direct the scientific study of the problems of flight with a view to their practical solution

(c) The rates of compensation for positions established pursuant to the provisions of this act shall not be less than $12,500 per annum nor more than $19,000 per annum and shall be subject to the approval of the Civil Service Commission.

SEC 2 Positions created pursuant to this Act shall be included in the classified civil service of the United States, but appointments to such positions shall be made without competitive examination upon approval of the proposed appointee's qualifications by the Civil Service Commission or such officers or agents as it may designate for this purpose

SEC. 3 The Secretary of Defense [1] and the Chairman of the National Advisory Committee for Aeronautics shall submit to the Congress, not later than December 31 of each year, a report setting forth the number of positions established pursuant to this Act in the National Military Establishment [1] and in the headquarters and research stations of the National Advisory Committee for Aeronautics, respectively,[1] during that calendar year, and the name, rate of compensation, and description of the qualifications of each incumbent, together with a statement of the functions performed by each In any instance where the Secretary [1] or the Chairman, respectively, may consider full public report on these items detrimental to the national security, he is authorized to omit such items from his annual report and, in lieu thereof to present such information in executive sessions of such committees of the Senate and House of Representatives as the presiding officers of those bodies shall designate.

[1] See sec 28 (b) of Act of August 10, 1956, C. 1041, 70A Stat. 631 (An Act to Revise, Codify, and Enact into Law, Title 10 of the United States Code, etc.)

ATTACHMENT 2

"SEC. 6. (a) The Agency shall—

* * * * * * *

"(b) In performance of the above functions the Agency is authorized—

"(1) * * *

"(2) subject to the civil service laws, to select, appoint, employ, and, subject to such regulations as the President may prescribe and without regard to the Classification Act of 1949, as amended (5 U. S. C 1072 et seq.), and the Federal Employees Pay Act of 1945, as amended (5 U. S. C. 901 et seq.), fix and adjust, as nearly as consistent with the public interest and on the basis of equal pay for equal work at rates which are reasonably comparable with prevailing rates paid by non-Federal employers for similar work, *the* compensation of such [officers and employees] *specially qualified scientific or professional personnel* as may be necessary to carry out the [provisions of] *research and development functions under* this Act;"

ATTACHMENT 3

"SEC. 6 (a) The Agency shall—

* * * * * * *

"(b) In performance of the above functions the Agency is authorized—

"(1) * * *

"(2) subject to the civil service laws, to select, appoint, employ, and, subject to such regulations as the President may prescribe and without regard to the Classification Act of 1949, as amended (5 U S C. 1072 et seq), and the Federal Employees Pay Act of 1945, as amended (5 U. S C 901 et seq), fix and adjust, as nearly as consistent with the public interest and on the basis of equal pay for equal work at rates which are reasonably comparable with prevailing rates paid by non-Federal employers for similar work, *the* compensation of such [officers and employees] *scientific or professional personnel* as may be necessary to carry out the [provisions of] *research and development functions under* this Act;"

ATTACHMENT 4

THE FEDERAL TOP SALARY NETWORK—BASIC AND HISTORICAL SALARY INFORMATION

United States Civil Service Commission, Bureau of Programs and Standards, Program Planning Division, Pay Systems Section, revised February 1958

I. INTRODUCTION

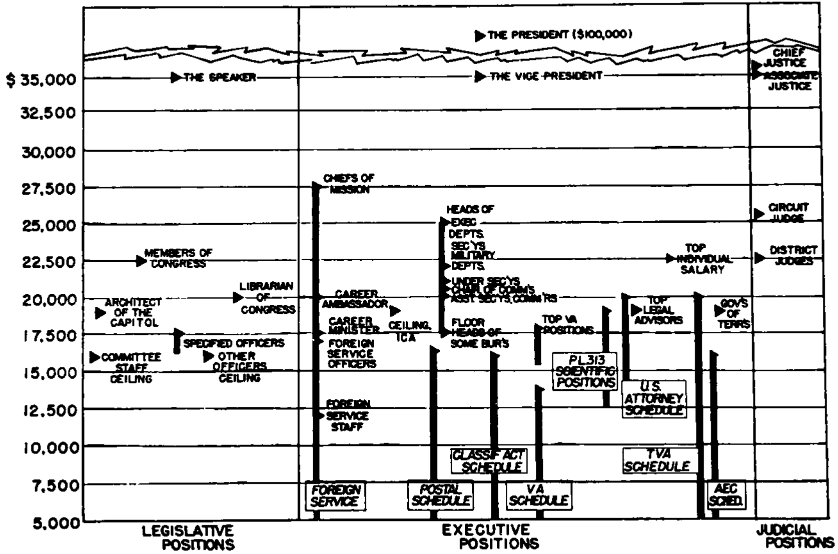
Apart from the President's compensation, a network of annual salary rates from $15,000 to $35,500 forms the top of the salary structure of the Federal Government. The executive, legislative, and judicial branches are all represented.

The rates of this network are either authorized or expressly fixed by statute. Some provisions apply to single positions, others cover classes of positions having substantially equivalent responsibilities; still others combine into a multiple-rate salary schedule. In many instances Congress has fixed a single statutory rate as the only lawful rate. Sometimes, however, it has delegated to an executive agency the authority to fix top salary rates, subject usually to limitations or guidelines, as in the case of the Atomic Energy Commission and the Tennessee Valley Authority. Sometimes, although rarely, it has delegated such power to the President.[1]

In this paper, we (1) show the composition of the Federal top salary network, identifying the various groups or items that should be considered in getting a well-rounded picture, and (2) review the history of top salaries.

[1] Reorganization Act of 1949, as amended and extended, Public Law 109, June 20, 1949, as amended by Public Law 85-286, September 4, 1957; sec. 703 (a), Defense Production Act, Public Law 774, September 8, 1950, as amended by Public Law 632, June 29, 1956.

THE FEDERAL TOP SALARY NETWORK



II. COMPOSITION OF TOP SALARY NETWORK

A considerable number of separate statutes, appropriation riders, and reorganization plans establish or authorize top salary schedules or rates. Within this group of authorizations the Federal Executive Pay Act of 1956 is but 1 statute although a major one, and the ceiling rate of the Classification Act is but 1 item, although a major limitation. Collectively, these schedules and rates constitute a network of top salary relationships within and between the legislative, judicial, and executive branches of the Government.

The composition of this network may be outlined as follows:

Executive branch

	Key rates
The President	$100,000
The Vice President	35,000
Judges, Court of Military Appeals	25,500
The Federal Executive Pay Act:	
Heads of executive departments	25,000
Secretaries of military departments	22,000
Under Secretaries	21,000
Chairmen of most independent boards and commissions	20,500
Assistant Secretaries	20,000
Members, other than chairmen, of most independent boards and commissions	20,000
Governors of Territories and possessions, the top legal adviser in most executive and military departments	19,000
Heads of some bureaus	17,500
Individual top salary provisions, ceiling	22,500
Ceilings of graded schedules:	
Classification Act of 1949, as amended, ceiling	16,000
Postal Field Service Compensation Act of 1955, as amended, ceiling	[1] 16,000
Department of Medicine and Surgery, Veterans' Administration:	
Chief Medical Director	17,800
Deputy Medical Director	16,800
Assistant Medical Directors	15,800
Medical and dental services, ceiling	13,760
Foreign Service, State Department:	
Chiefs of mission:	
Ceiling	27,500
Floor	20,000
Career Ambassador	20,000
Career Minister	17,500
Foreign Service officers, ceiling	17,000
Foreign Service Staff officers and employees, ceiling	11,965
Ceilings of occupational groups:	
Certain professional or scientific research and developmental groups for which Congress has fixed only a minimum rate and a maximum rate:	
Ceiling	19,000
Floor	12,500
United States attorneys and assistant United States attorneys:	
United States attorneys:	
Ceiling	20,000
Floor	12,000
Assistant United States attorneys, ceiling	15,000
Agency ceilings:	
Tennessee Valley Authority, ceiling	20,000
Atomic Energy Commission:	
Scientific and technical personnel, ceiling	19,000
Nonscientific and nontechnical personnel, ceiling	16,000
International Cooperation Administration	19,000

[1] Plus 3 longevity increases of $100 each.

II. COMPOSITION OF TOP SALARY NETWORK—continued

Legislative Branch

	Key rates
The Speaker	$35,000
Members of Congress	22,500
Officers of the Congress:	
Secretary of the Senate, Sergeant at Arms	17,500
Clerk of the House, Sergeant at Arms	17,500
Parliamentarian of the House	20,500
Legislative counsel, Senate	17,500
Legislative counsel, House	16,125
Other officers, ceiling	16,000
Members of committee staffs, ceiling	16,000
Chief of staff, Joint Committee on Internal Revenue Taxation	17,500
Other legislative agencies:	
Librarian of Congress	20,000
Architect of the Capitol	19,000

Judicial Branch

The Federal judiciary:	
Chief Justice of the United States	$35,500
Associate Justices, Supreme Court	35,000
Circuit judges	25,500
District judges	22,500

III. EXECUTIVE BRANCH

A. The President

1789	$25,000
1873	50,000
1909	75,000
1949	100,000

The President's official compensation is $150,000. Of this, $100,000 is salary and $50,000 expense allowance.

Originally established in 1789 at $25,000 a year, the President's salary was raised to $50,000 a year in 1873 and to $75,000 a year in 1909. Effective January 20, 1949, Congress increased it to its present figure of $100,000 (Public Law 2, 81st Cong , January 19, 1949). [1]

In the same law Congress also granted the President an annual expense allowance of $50,000 "to assist in defraying expenses relating to or resulting from the discharge of his official duties." This expense allowance, like those of Members of Congress, the Vice President, and the Speaker, was at first tax-exempt, but the exemption was removed, effective January 20, 1953, by the Revenue Act of 1951. The President is required to account for this allowance for income-tax purposes only.[2]

The President has, of course, the use of the White House and its furnishings, for the care and maintenance of which Congress makes an annual appropriation. Basic law (act of June 23, 1906, as amended August 2, 1946) also authorizes Congress to appropriate and the President to spend not more than $40,000 annually for traveling expenses. Customarily, in current appropriations Congress authorizes travel, official entertainment, and other White House Office expenses in lump sum, without specific limitation on travel

The President is not covered by the Civil Service Retirement Act, A bill, S. 607, passed the Senate on February 4, 1957, which would (*a*) provide each former President of the United States with a monetary allowance of $25,000 per annum for life, (*b*) authorize him to select and employ his own staff, with a limitation on their aggregate compensation, (*c*) authorize suitable office space; and (*d*) grant free postage privileges. No action was taken on the bill by the House of Representatives before the 1st session of the 85th Congress adjourned.

[1] The salary of the President was unaffected by the reductions which took place during the period 1932 to 1935 Art II, sec 1, of the Constitution provides that the compensation of the President "shall neither be increased nor diminished during the period for which he shall have been elected "

[2] Sec 619 of the Revenue Act of 1951, Public Law 183, 82d Cong , approved October 20, 1951, removed the tax exemption from the expense allowances of the President, the Vice President, the Speaker and Members of Congress It struck out the language "no tax liability shall accrue and for which no accounting shall be made by him" and inserted in lieu thereof "no accounting other than for income tax purposes shall be made by him " The expense allowances of the President, the Vice President, and the Speaker are still in effect. Those for Members of Congress were eliminated by sec 4 (b) of Public Law No. 9, 84th Cong.

B. The Vice President

1789	$5,000	1925	$15,000
1853	8,000	1946	20,000
1873	10,000	1949	30,000
1874	8,000	1955	35,000
1909	12,000		

The Vice President's official compensation is $45,000 a year. Of this, $35,000 is salary and $10,000 expense allowances [3]

The salary of the Vice President was first fixed at $5,000 a year in 1789. Successively, it was changed to $8,000 in 1853, to $10,000 in 1873, to $8,000 in 1874 (on repeal of the 1873 provision), to $12,000 in 1909, to $15,000 in 1925, to $20,000 in 1946, to $30,000 in 1949, and to its existing rate of $35,000 by Public Law 9, 84th Congress, effective March 1, 1955.[4]

Public Law 2, 81st Congress, approved January 19, 1949, granted the Vice President an expense allowance of $10,000 a year "to assist in defraying expenses relating to or resulting from the discharge of his official duties, for which no tax liability shall occur or accounting be made by him." The provision freeing this expense allowance from tax liability was repealed, effective January 20, 1953, by the Revenue Act of 1951.

C. The Federal Executive Pay Act of 1956

Coverage.—The Federal Executive Pay Act of 1956, title I of Public Law 854, 84th Congress, July 31, 1956, identified by title and fixed the statutory salary rates of 307 positions in the executive, legislative, and judicial branches of the Government [5] Of these, 284 were in the executive branch, 9 were in the legislative branch;[6] and 14 were in the judicial branch.[7] For most of these positions this was new legislation. However, for the 10 top positions in the Bureau of Medicine and Surgery, the new rates were prescribed by amending existing statutory provisions.

The act also amended the Classification Act of 1949, as amended, and the postal Field Service Compensation Act of 1955 by increasing the top salary rates in their statotory schedules Other amendments in the act increased the minimum and maximum salary rates which certain departments and agencies are authorized by various statutes to establish for specified types or groups of positions.[8]

The laws governing the statutory salary rates for top positions in the Atomic Energy Commission and in the Foreign Service under the Department of State were not amended by the Federal Executive Pay Act.

Major salary groupings

Within the scope of the Federal Executive Pay Act itself, the content of the salary brackets may briefly be described or illustrated as follows:

$25,000—Heads of the 10 executive departments.

$22,500—Deputy Secretary of Defense, Under Secretary of State, Comptroller General of the United States, Director of Defense Mobilization, and the Director of the Bureau of the Budget. This rate is also the maximum limitation on the salary rate of two Presidential aids.

$22,000—Secretaries of the three military departments (Army, Navy, and Air Force).

$21,000—Under Secretaries of 9 executive departments (including the Deputy Postmaster General), President of the Export-Import Bank of Washington, and the heads of 8 single-headed independent establishments (Federal Civil Defense

[3] H. R. 498 and S 2623, introduced in the 1st sess of the 85th Cong, proposed to increase the allowance of the Vice President to $25,000, to provide $20,000 for traveling expenses, and to authorize two administrative assistants with gross salaries not exceeding $18,000 per annum each. Neither of these bills was reported before the first session adjourned

[4] Economy legislation effective in 1932–35 reduced the Vice President's compensation ($15,000) by 15 percent, 10 percent, and 5 percent successively during that period

[5] Prior to Public Law 854, 84th Cong, the salary rates for almost three-fourths of these positions were fixed by the Executive Pay Act of 1949 (Public Law 359, 81st Cong, October 15, 1949, as amended) Pay rates under that act ranged from $22,500 for Cabinet officers to $14,800 for the heads of some major bureaus Some of the 307 positions were formerly paid under the scales of the Classification Act of 1949, others had their rates fixed by various statutes and reorganization plans With few exceptions, the salary rates for top positions in the executive branch are now prescribed by a single statute—the Federal Executive Pay Act of 1956

[6] Architect of the Capitol, Assistant Architect of the Capitol, Comptroller General, Assistant Comptroller General, Librarian of Congress, Chief Assistant Librarian of Congress, Public Printer, Deputy Public Printer, and the Chief of Staff of the Joint Committee on Internal Revenue Taxation

[7] Director and Assistant Director of the Administrative Office of the United States Courts and 12 commissioners of the United States Court of Claims

[8] For example, limitations on certain professional and scientific positions discussed on page 24 of this document and the maximum rates for 15 Presidential aids

Administration, General Services Administration, Housing and Home Finance Agency, Veterans' Administration, Central Intelligence Agency, International Cooperation Administration, United States Information Agency, and the Farm Credit Administration). This is also the rate for the positions of the Director, Federal Bureau of Investigation, and the Commission of Internal Revenue and is the maximum limitation on the salary rate of three Presidential aids. (A rate of $22,000 is provided for the present Director of the Federal Bureau of Investigation.)

$20,500—Chairmen of boards and commissions (20 in number), 3 Deputy Under Secretaries of State, the Comptroller of the Currency, the Director of the Federal Mediation and Conciliation Service, the First Vice President of the Export-Import Bank of Washington, and the deputy and assistant heads of 7 single-headed independent establishments (the Assistant Comptroller General of the United States, the Deputy Administrator of Veterans' Affairs and the Federal Civil Defense Administration; and the Deputy Directors of the Bureau of the Budget, the Central Intelligence Agency, the Office of Defense Mobilization, and the United States Information Agency).

$20,000—Assistant Secretaries of 9 executive departments, Under and Assistant Secretaries of the 3 military departments, members of most independent boards and commissions, heads of 8 single-headed independent establishments (Small Business Administration, St. Lawrence Seaway Development Corporation, Administrative Office of the United States Courts, National Advisory Committee for Aeronautics, National Science Foundation, Selective Service System, Library of Congress, and the Government Printing Office). This is also the rate for the heads of some of the major bureaus and offices under the departments and agencies (the Administrators of Civil Aeronautics, Commodity Stabilization Service, the Rural Electrification Administration, and the Wage and Hour and Public Contracts Divisions, the Commissioners of Community Facilities, Federal Housing Administration, Public Housing Administration, Urban Renewal Administration, and the Director of the Bureau of Prisons. It is also the maximum limitation on the salary rate for seven Presidential aids and is the total compensation rate for the Surgeon General of the Public Health Service, exclusive of his allowance under the Career Compensation Act of 1949, as amended.

$19,000—Governors of Alaska, Hawaii, Guam, the Virgin Islands, and the Canal Zone, the Architect of the Capitol, the Assistant to the Director of the Federal Bureau of Investigation, and the 12 Commissioners of the United States Court of Claims. It is also the rate for the legal adviser, solicitor, or general counsel of most executive or military departments and is the total compensation rate for the Deputy Surgeon General of the Public Health Service exclusive of his allowances under the Career Compensation Act of 1949, as amended. This is also the maximum rate for 21 positions in the International Cooperation Administration and for a limited number of professional and scientific positions in specified departments and agencies.

$18,000—Three Commissioners of the Indian Claims Commission.[9]

$17,800—Chief Medical Director, Department of Medicine and Surgery, Veterans' Administration.

$17,500—Heads of some major bureaus such as the Agricultural Research Service, Bonneville Power Administration, Farmers' Home Administration, Soil Conservation Service, Forest Service, Customs, Federal Supply Service, Immigration and Naturalization, Narcotics, Public Buildings Service, Public Roads, Reclamation, Social Security, and Federal Crop Insurance Corporation. This is also the rate for the Chief of Staff of the Joint Committee on Internal Revenue Taxation, the Deputy Commissioner of the Internal Revenue Service, and the assistant or deputy heads of some single-headed agencies (Assistant Architect of the Capitol, Assistant Director of the Administrative Office of the United States Courts, the Associate Director of the Federal Mediation and Conciliation Service, Chief Assistant Librarian of Congress, Deputy Administrator of the St. Lawrence Seaway Development Corporation, and the Deputy Public Printer). It is also the maximum limitation on the salary rate of three Presidential aids and is the total compensation rate for each of the following employees in addition to their allowances under the Career Compensation Act of 1949, as amended: Director, National Institutes of Health; Chief, Bureau of State Services, and Chief, Bureau of Medical Services, all in the Public Health Service.

[9] The Chief Commissioner receives $500 more as "head" of the Commission under sec. 108 of the act.

$17,000—Three Deputy Administrators of the Small Business Administration and the Treasurer of the United States.

$16,800—Deputy Chief Medical Director, Department of Medicine and Surgery, Veterans' Administration.

$15,800—Assistant Chief Medical Directors, Department of Medicine and Surgery, Veterans' Administration.

History of Cabinet officers' salary rates

	State	Treasury	Attorney General	Postmaster General [1]	Interior	Agriculture	Commerce	Labor	Defense [2]	Health, Education, and Welfare
1789	$3,500	$3,500	$1,500							
1792	--------	--------	--------	$2,000						
1794	--------	--------	--------	2,400						
1797	--------	--------	2,000	--------						
1799	5,000	5,000	3,000	3,000						
1819	6,000	6,000	3,500	4,000						
1827	--------	--------	--------	6,000						
1849	--------	--------	--------	--------	$6,000					
1850	--------	--------	6,000	--------	--------					
1853	8,000	8,000	8,000	8,000	8,000					
1873	10,000	10,000	10,000	10,000	10,000					
1874 [3]	8,000	8,000	8,000	8,000	8,000					
1889	--------	--------	--------	--------	--------	$8,000				
1903	--------	--------	--------	--------	--------	--------	$8,900			
1907	12,000	12,000	12,000	12,000	12,000	12,000	12,000			
1913	--------	--------	--------	--------	--------	--------	--------	$12,000		
1925 [4]	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000		
1947	--------	--------	--------	--------	--------	--------	--------	--------	$15,000	
1949	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500	
1953	--------	--------	--------	--------	--------	--------	--------	--------	--------	$22,500
1956	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000

[1] The Postmaster General became a member of the President's Cabinet in 1829. The Post Office Department became an executive department in 1872.

[2] The Departments of War and Navy, the Secretaries of which were members of the President's Cabinet until 1947, are now military departments under the Department of Defense. As Cabinet officers the salary rate for each Secretary was essentially the same as for Secretary of State

[3] In 1873 Congress increased the pay of top legislative, judicial, and executive officials. (Act of Mar. 3, 1873, 17 Stat. 486) The new rates, however, were repealed the next year, except for the President and Justices of the Supreme Court (Act of Jan. 20, 1874, 18 Stat (pt. 3) 4)

[4] Economy legislation effective in 1932–35 reduced rates 15, 10, and 5 percent successively during that period.

D. Individual top salary provisions

In addition to the positions covered in the Federal Executive Pay Act of 1956, there are 70 other top administrative positions in the executive branch outside the Foreign Service of the State Department for which Congress has fixed a specific individual salary rate or maximum limitation at $15,000 or more.

Thirty-one of these positions have their rates fixed by three statutes which were enacted prior to the Federal Executive Pay Act of 1956. These are—

Three judges of the Court of Military Appeals, Department of Defense whose compensation was fixed at $25,500 by Public Law 9, 84th Congress, effective March 1, 1955.

Ten positions in the Department of Justice which were taken out of the Executive Pay Act of 1949 and given pay increases by Public Law 9, 84th Congress, effective March 1, 1955 These are the Deputy Attorney General ($21,000), the Solicitor General ($20,500), and eight Assistant Attorneys General ($20,000).[10]

Sixteen judges of the Tax Court of the United States ($22,500): The United States Board of Tax Appeals was created by the Revenue Act of 1924 The act of October 21, 1942, changed its name to the Tax Court of the United States.

The salary rate of the 16 judges of the Tax Court of the United States was fixed in 1924 at $7,500, increased in 1939 to $10,000, and in 1946 to $15,000. Public Law 9, 84th Congress, approved March 2, 1955, effective March 1, 1955, raised it to $22,500 per annum The court is in the executive branch but the salary rate of the judges is customarily tied to adjustments in the rates of Federal judges in the judicial branch

[10] Under the Executive Pay Act of 1949, the salary rates for these positions in the Department of Justice were the same as for parallel positions in other executive departments. After they were increased by Public Law 9, numerous bills were introduced to give similar raises to other top executives Such increases were approved in the Federal Executive Pay Act of 1956, July 31, 1956, and made retroactive to the beginning of the first pay period commencing after June 30, 1956

The Agricultural Surplus Disposal Administrator, whose salary is fixed by the Secretary of Agriculture at a rate not in excess of $15,000 under the provisions of Public Law 540, April 28, 1956.

The General Counsel, Department of Health, Education, and Welfare, whose salary is fixed "at the rate now or hereafter provided by law for Assistant Secretaries of executive departments" by Public Law 852, July 31, 1956. The Federal Executive Pay Act, which was enacted almost simultaneously, prescribes a rate of $20,000 per annum for Assistant Secretaries of executive departments.[11]

Thirty-nine other positions (many newly created) are paid at rates fixed by statutes enacted after the Federal Executive Pay Act. Some have their salary rates prescribed by reference to either (1) the rate for a specified group under the Federal Executive Pay Act or (2) a grade of the Classification Act of 1949, as amended. Others have their salary rates specifically stated in the laws:

Assistant Director of the Bureau of the Budget.—Public Law 882, August 1, 1956, established this one additional Assistant Director position and provided that the compensation "shall be the same as is now or may hereafter be provided for the two such positions heretofore authorized by law." (The rate currently prescribed by the Federal Executive Pay Act is $20,000.)

Federal Highway Administrator.—Public Law 966, August 3, 1956, provides compensation "at the rate prescribed by law for Assistant Secretaries of executive departments." (Assistant Secretaries of executive departments receive $20,000 per annum under the Federal Executive Pay Act.)

Assistant Secretary for Fish and Wildlife and Commissioner of Fish and Wildlife.—Public Law 1024, August 8, 1956, provides that the Assistant Secretary "shall be compensated at the same rate as other Assistant Secretaries" and the Commissioner "shall receive compensation at the same rate as that provided for grade GS-18." (Under the Federal Executive Pay Act, the rate for Assistant Secretaries is $20,000 and the rate for grade GS-18 of the Classification Act of 1949, as amended, is $16,000.)

Administrative Assistant Secretary, Department of the Interior.—Public Law 85-167, August 26, 1957, provides that the salary for this position "shall be the same as the Solicitor of the Department of the Interior." (The Solicitor's salary is $19,000, under the Federal Executive Pay Act.)

General Counsel, Department of Defense.—Public Law 85-170, August 28, 1957, provides that this position shall be paid "at the rate prescribed by Reorganization Plan No. 6 approved June 30, 1953 (67 Stat. 638)." Under Reorganization Plan No. 6 of 1953, the salary for the General Counsel for the Department of Defense was fixed at the rate "for Assistant Secretaries of executive departments." In 1956, this provision was superseded by section 106 (b) (9) of the Federal Executive Pay Act which prescribed a salary of $19,000 per annum for each "legal adviser, solicitor, or general counsel of an executive or military department (excluding the Department of Justice)." The effect of Public Law 85-170 was to increase the salary of the General Counsel, Department of Defense, from $19,000 to $20,000, the rate prescribed by the Federal Executive Pay Act for Assistant Secretaries of executive departments.

Chairman, Airways Modernization Board.—Public Law 85-133 prescribes a rate of $20,500 for this position.

Manager of the Fund, International Cooperation Administration.—Public Law 85-141, August 14, 1957, set up a Development Loan Fund and provided that the Manager of the Fund could receive compensation "at a rate not in excess of $19,000 a year."

Twenty-nine positions in the Atomic Energy Commission.—Public Law 85-287, September 4, 1957, raised the statutory rates for 19 top positions in the Atomic Energy Commission which have traditionally had their rates fixed by special statutes. The new rates are: Chairman, $22,500; 4 members, $22,000; General Manager, not to exceed $22,000; General Counsel, not to exceed $19,500; and 12 division directors, not to exceed $19,000. The act also provided statutory salary limitations for 10 additional top-management positions, as follows: Deputy General Manager, not to exceed $20,500; 3 Assistant General Managers or their equivalents, not to exceed $20,000; and 6 other executive-management positions, not to exceed $19,000.

Assistant Attorney General, Department of Justice.—Public Law 85-315, September 9, 1957, established this one additional Assistant Attorney General position and provided compensation "at the rate prescribed by law for other

[11] The Federal Executive Pay Act of 1956 prescribed a salary rate of $19,000 for the chief legal officer of each executive and military department (except Justice). However, the language in Public Law 852 was interpreted as superseding this provision as it related to the General Counsel of the Department of Health, Education, and Welfare.

Assistant Attorneys General." (The salary rate for Assistant Attorneys General is fixed at $20,000 by Public Law 9, March 2, 1955.)

Staff Director, Commission on Civil Rights.—Public Law 85-315, September 9, 1957, provided that a full-time staff director for the Commission on Civil Rights "shall receive compensation at a rate, to be fixed by the President, not in excess of $22,500 a year."

Without changing the salary rates of the positions involved, Congress has in several instances authorized increased rates for the then present incumbents only. The following are current:

	Rate for position	Rate for present incumbent
Position under Federal Executive Pay Act. Director, Federal Bureau of Investigation	$21,000	$22,000
Positions under the Classification Act:		
Comptroller, General Services Administration		[1] 16,000
Administrative Assistant Attorney General (GS-18)	16,000	17,500
Administrator, Southwestern Power Administration (GS-16)	[2] 13,760	[3] 17,500

[1] Present incumbent receives "rate for GS-18."
[2] Maximum
[3] Present incumbent receives same rate as the Administrator, Bonneville Power Administration.

E. Ceilings of graded schedules

The Federal top salary network embraces and controls the ceiling rates of graded schedules established by statute for four major segments of the career service. These schedules and the approximate number of positions which each one covered on June 30, 1957, are as follows.

	Number
The general schedule of the Classification Act of 1949, as amended	[1] 978,750
The schedules for the postal field service under the Postal Field Service Compensation Act of 1955, Public Law 68, 84th Cong., June 10, 1955, as amended	447,000
The Foreign Service schedules of the Foreign Service Act of 1946, as amended	[2] 12,750
The medical, dental, and nursing schedules and rates of the act of Jan. 3, 1946, Public Law 293, 79th Cong., as amended	20,000

[1] Includes positions in the municipal government for the District of Columbia.
[2] Includes positions in the International Cooperation Administration and in the U. S. Information Agency.

Classification Act of 1949, as amended.—The Classification Act of 1949 is a statute of general applicability, not confined to any one department, agency, or occupational group. Its general schedule fixes the rates of pay for professional, scientific, administrative, supervisory, office and other white collar workers in most of the departments and agencies.

The general schedule embraces 18 grades or zones of difficulty and responsibility. Each grade has a statutory range of pay with a scheduled minimum and a scheduled maximum. A longevity step-increase plan permits rates above scheduled maximums in grades GS-1 through GS-15. The longevity step-increase plan does not apply to the three highest grades of the general schedule.

The three highest grades, GS-16, GS-17, and GS-18, were established for the first time in 1949. The number of positions now allowed in these so-called supergrades is 1,226, exclusive of a few statutory exceptions.

The following table shows the characteristics of the top grades of the Classification Act general schedule.

GS grade	Maximum number of positions authorized [1]	Scheduled minimum	Scheduled maximum	Number of rates	Number and amount of steps	Longevity step—increases over maximum
15		$11,610	$12,690	5	4 at $270	3 at $215
16	767	12,900	13,760	5	4 at $215	None
17	329	13,975	14,835	5	4 at $215	None
18	130	16,000		1	Single rate	None.

[1] Exclusive of certain statutory exceptions and other authorizations.

Postal Field Service Compensation Act of 1955, as amended.—For many years pay rates in the postal field service have been fixed by acts of Congress separately from other groups.

Public Law 68 of the 84th Congress, approved June 10, 1955, establishes a set of graded schedules for the postal field service for the first time. There are three such schedules: The postal field service schedule, the rural carrier schedule, and the fourth-class postmaster schedule. The problems which concern salary ceilings involve only the postal field service schedule. This schedule has a scheduled maximum rate of $16,000. This is a single rate, established for level 20 in the schedule. Under the act, however, after 13, 18, and 25 years of postal service, an employee may earn 1, 2, and 3 longevity step increases of $100 each over the scheduled maximum rate of his level

Section 301 (a) of Public Law 68 establishes the postal field service schedule. Section 201 (c) limits the number of positions that may be placed in levels 17, 18, 19, and 20. Section 404 provides a longevity step-increase plan.

The effect of these various provisions of Public Law 68 as amended by Public Law 854, July 31, 1956, on the top grades of the postal field service schedule may be outlined as follows:

PFS Level	Maximum number of positions authorized	Scheduled minimum	Scheduled maximum	Number of rates	Number and amount of steps	Longevity step-increases over maximum
17	40	$11,400	$13,200	7	6 at $300	3 at $100.
18	12	12,800	14,600	7	do	Do
19	4	14,000	15,200	5	4 at $300	Do.
20	15	16,000		1	Single rate	Do.

Foreign Service.—The Foreign Service Act of 1946, as amended, establishes three statutory schedules for officers and employees of the Foreign Service under the State Department. These schedules are also used to compensate certain overseas personnel of other agencies, such as the United States Information Agency and the International Cooperation Administration. (Sec. 527 (c), Mutual Security Act of 1954, as amended, Public Law 665, 83d Cong., August 26, 1954; Executive Order 10610, May 9, 1955.)

The three schedules are for·

Chiefs of Mission (sec. 411): Four classes as follows Class 1, $27,500; class 2, $25,000; class 3, $22,500 and class 4, $20,000.

Foreign Service officers and Foreign Service reserve officers (sec. 412): 10 classes with associated salary ranges or rates. The minimum of the schedule is $4,300. The top rates are: The single rate of $20,000 for career ambassador; the single rate of $17,500 for career minister, and the $17,000 maximum rate for Foreign Service officer class 1 The schedule for Foreign Service officers applies to Foreign Service reserve officers.

Foreign Service staff officers and employees (sec. 415) 22 classes, beginning with a minimum of $1,455 in class 22 and running to the maximum rate of class 1 which is $11,965.

A $17,500 salary ceiling rate was authorized for ambassadors as early as 1855 (act of March 1, 1885, 10 Stat 619, sec. 1). It was raised to $25,000, effective November 13, 1946, by the Foreign Service Act of 1946, Public Law 724, 79th Congress, August 13, 1946 The present $27,500 rate was established by Public Law 828, July 28, 1956, which amended the Foreign Service Act of 1946.

The salaries at the top structure of the Department of State are as follows: Secretary of State, $25,000; Under Secretary of State, $22,500; 3 Deputy Under Secretaries, $20,500; 10 Assistant Secretaries, $20,000. The rates for these executives are fixed by the Federal Executive Pay Act of 1956.

The history of the top rates in the Foreign Service schedules is shown in the following table.

Maximum rates, foreign service schedules, 1946–56

	Approximate number of employees [1] October 1957	Public Law 724, 79th Cong., August 13, 1946 effective November 13, 1946	Public Law 160, 81st Cong., July 6, 1949 effective July 11, 1948	Public Law 201, 82d Cong., October 24, 1951 effective July 8, 1951	Public Law 94, 84th Cong., June 28, 1955 effective March 13, 1955	Public Law 250 84th Cong. effective August 5, 1955	Public Law 828 84th Cong. effective July 29, 1956
Chiefs of mission (79)							
Class 1	14	$25,000	(2)	(2)	(2)	(2)	$27,500
Class 2	27	20,000	(2)	(2)	(2)	(2)	25,000
Class 3	22	17,500	(2)	(2)	(2)	(2)	22,500
Class 4	16	15,000	(2)	(2)	(2)	(2)	20,000
Foreign Service officers (including FSRO):							
Career ambassador	2	----------	----------	----------	----------	$15,000	20,000
Career minister	14	13,500	$13,500	$14,300	$14,800	(2)	17,500
Class 1	[3] 5	13,500	13,500	14,300	14,800	(2)	17,000
Foreign Service Staff officers and employees: Class 1	[4] 113	10,000	10,300	11,130	11,965	(2)	(2)

[1] Includes positions in International Cooperation Administration and in the U S Information Agency.
[2] No change.
[3] Maximum number out of total of 212 in class 1.
[4] Maximum number out of total of 350 in class 1.

Veterans' Administration, Department of Medicine and Surgery.—The Department of Medicine and Surgery in the Veterans' Administration was established by Public Law 293, 79th Congress, January 3, 1946. That act, as amended and supplemented, fixes the pay for the Chief Medical Director and 35 other top positions in the Department by specifying the salaries for designated positions. It also establishes three graded schedules—the Medical, Dental, and Nursing Services. The most recent amendment to Public Law 293 was contained in the Federal Executive Pay Act of 1956.

As of June 30, 1957, these schedules covered almost 20,000 full-time positions: 4,619 physicians, 769 dentists, and 14,379 nurses.

The statutory rates for 10 of the top positions were increased, along with those for many other Federal executives, by the provisions of the Federal Executive Pay Act of 1956. These are the Chief Medical Director ($17,800), the Deputy Chief Medical Director ($16,800), and not to exceed 8 Assistant Medical Directors ($15,800). Under the Federal Executive Pay Act the salary of the Administrator of Veterans' Affairs is $21,000 and that of the Deputy Administrator is $20,500.[12]

The history of the establishment of maximum rates for the 36 positions and the 3 schedules concerned is shown in the following table:

[12] During the 1st sess of the 85th Cong. a bill, H R. 6719, was introduced to provide, among other things, salary increases for certain professional employees of the Department of Medicine and Surgery. The bill, as amended and reported by the House Committee on Veterans' Affairs (Rept. No. 796, pts 1 and 2), proposed a rate of $19,500 for the Chief Medical Director, $18,500 for the Deputy Chief Medical Director, $17,500 for each Assistant Chief Medical Director, and $16,000 for directors of service or chiefs of division. Increases were also proposed for the Director, Nursing Service, the chief dietitian and the chief pharmacist, as well as for employees paid under the schedules for the Medical, Dental, and Nursing Services. The House did not take action on H R 6719 before the 1st session of Congress adjourned.

Maximum rates, positions and schedules, Veterans Administration, Department of Medicine and Surgery, 1946–56

	Public Law 293, 79th Cong, January 3, 1946	Public Law 349, 81st Cong, October 12, 1949, effective December 1, 1949	Public Law 201, 82d Cong, October 24, 1951, effective July 8, 1951	Public Law 94, 84th Cong, June 28, 1955, effective March 13, 1955	Public Law 854, 84th Cong, July 31, 1956, effective July 1, 1956
Chief Medical Director (1)	$12,000	$16,000	$16,800	(1) (2)	$17,800
Deputy Chief Medical Director (1)	11,500	15,000	15,800	(1) (2)	16,800
Assistant Chief Medical Directors (note 8)	11,000	14,000	14,800	(1) (2)	15,800
Directors of Service or Chief of Division (note 20)		12,500	13,300	$14,300	(2)
Director, Nursing Service (1)	8,000	10,000	10,800	11,610	(2)
Deputy Director, Nursing Service (1)	7,000	8,800	9,600	10,320	(2)
Chief pharmacist (1)	6,000	8,800	9,600	10,320	(2)
Chief dietitian (1)	6,000	8,800	9,600	10,320	(2)
Chief physical Therapist (1)	6,000	8,800	9,600	10,320	(2)
Chief occupational therapist (1)	6,000	8,800	9,600	10,320	(2)
Highest rate, Medical Service [3]	9,800	11,000	11,800	12,685	(2)
Highest rate, Dental Service [3]	8,225	11,000	11,800	12,685	(2)
Highest rate, Nursing Service	6,020	7,400	8,040	8,645	(2)

[1] Public Law 94, 84th Cong, increased no salary above $14,800

[2] No change

[3] An additional 25 percent may be paid to those who are rated as medical, surgical, or dental specialists. The aggregate limit, originally $11,000, was raised to $12,000 by Public Law 758, 81st Cong., Sept. 5, 1950, to $12,800 by Public Law 201, 82d Cong, and to $13,760 by Public Law 94, 84th Cong

Ceilings of statutory schedules—Chronology.—The history of ceiling relationships among these four statutory schedules is shown in the following table:

Ceilings of statutory schedules, chronology

	1924	1925	1928	1930	1931	1945	1946	1948	1949	1950	1951	[1] 1955	[2] 1956
Classification Act	$7,500		$9,000			$9,800 00	$10,000	$10,330	$14,000		$14,800	$14,800	$16,000
Postal Field Service		$8,000		$12,000			12,400	[3] 13,150	[3] 13,270		[3] 14,070	[3] 15,100	[3] 16,300
Foreign Service													
Chiefs of mission	17,500						25,000		25,000		25,000	25,000	27,500
Career Ambassador												[4] 15,000	20,000
Career Minister							[5] 13,500		13,500		14,300	14,800	17,500
Foreign Service officers	9,000				$10,000	10,000 00	13,500		13,500		14,300	14,800	17,000
Staff officers and employees					[6] 4,000	7,102 20	10,000		10,330		11,130	11,965	
Medicine and Surgery—VA													
Chief Medical Director							12,000		16,000		16,800	16,800	17,800
Deputy Chief Medical Director							11,500		15,000		15,800	15,800	16,800
Assistant Chief Medical Directors							11,000		14,000		14,800	14,800	15,800
Director, Nursing Service							8,000		10,000		10,800	11,610	
Medical Service schedule							[7] 11,000		[7] 12,000		[7] 12,800	[7] 13,760	
Dental Service schedule							8,225		11,000	[7] 12,000	[7] 12,800	[7] 13,760	
Nursing Service schedule							6,020		7,400		8,040	8,645	

[1] Changes from 1951 are based on Public Law 94, 84th Cong

[2] All 1956 rates were fixed by Public Law 854, 84th Cong, except those in the Foreign Service which were established by Public Law 828, 84th Cong

[3] Maximum limitation on aggregate of highest scheduled basic rate plus 3 longevity increases of $100 each after 13, 18, and 25 years of service, respectively

[4] Class of Career Ambassador established by Public Law 250, 84th Cong, Aug 5, 1955

[5] Class of Career Minister established by Public Law 724, 79th Cong, Aug 13, 1946

[6] Ceiling for "senior clerk", a $5,600 ceiling for "administrative officer, class 1" was established by law May 3, 1945, this ceiling was revised to $7,102 20 by statute in July 1945

[7] Maximum limitation on aggregate of scheduled basic rate plus not to exceed 25 percent additional for specialist rating

F. Ceilings of occupational groups

Professional or scientific research and development positions in specified agencies.

In several enactments since 1947, Congress has authorized a specified salary range (in the Department of Agriculture and the Airways Modernization Board, a maximum) for a limited number of professional or scientific research and development positions in the Department of Defense, the National Security Agency, the National Advisory Committee for Aeronautics, the Public Health Service, the Department of Agriculture and the Airways Modernization Board. The original salary range of $10,000–$15,000 was increased to $12,500–$19,000 by the Federal Executive Pay Act of 1956, effective at the beginning of the first pay period commencing after June 30, 1956 [13] Simultaneously, the maximum for such positions in the Department of Agriculture was raised from $15,000 to $19,000. Except in the Department of Agriculture, the Civil Service Commission must approve in advance the salary rate to be established for each position and any subsequent changes within the $12,500–$19,000 range

The number of such positions now authorized is as follows:

Agency	Number of positions	Authority
Department of Defense	120	Public Law 1028, 84th Cong, Aug 10, 1956, as amended by Public Law 854, 84th Cong, July 31, 1956.[1]
	15	Public Law 85-322, Feb 11, 1958
National Security Agency	25	Public Law 313, 80th Cong, Aug 1, 1947, as amended by Public Law 758, 80th Cong, June 24, 1948, Public Law 167, 81st Cong, July 13, 1949 and Public Law 854, 84th Cong, July 31, 1956
National Advisory Committee for Aeronautics	30	
Public Health Service	60	Public Law 410, 78th Cong, July 1, 1944, as amended by Public Law 692, 81st Cong, Aug 15, 1950, Public Law 195, 84th Cong, Aug 1, 1955, and Public Law 854, July 31, 1956
Department of Agriculture	5	Act of May 29, 1884, as amended by Public Law 496, 80th Cong, Apr 24, 1948, and Public Law 854, July 31, 1956
Airways Modernization Board	5	Public Law 85-133, August 14, 1957.

[1] Prior to the recodification of title 10 of the U S Code in Public Law 1028, 84th Cong, this authority was contained in Public Law 313, 80th Cong, as amended

United States attorneys and assistant United States attorneys—As a result of certain mandatory requirements of the act of July 3, 1930, the scope of the pay schedules of the Classification Act was extended to include U S attorneys and assistant U S attorneys Between 1930 and 1953 rates for these positions were fixed administratively by the Department of Justice pursuant to Classification Act schedules, except that a special authority permitted a $10,000 rate for United States attorneys at New York City, Chicago, and Washington. During that period the ceiling of the Classification Act was increased from $9,000 to $14,800.

Section 202 of the Department of Justice Appropriation Act, 1954 (Public Law 195, 83d Cong, August 5, 1953) took United States attorneys and Assistant United States Attorneys out of the Classification Act schedules It established for the Attorney positions a range from $10,000 minimum to $15,000 maximum and for the assistant positions a range from $6,000 to $12,000

Public Law 471, 83d Congress, July 2, 1954, eliminated both minimum figures.

Effective March 1, 1955, Public Law 9, 84th Congress, March 2, 1955, raised these limitations United States attorneys may be paid not less than $12,000 nor more than $20,000, assistant United States attorneys not more than $15,000 (28 U S C 508)

[13] The maximum of the range for positions in the Public Health Service was raised to $20,000 by Public Law 635, June 29, 1956, but was later changed by Public Law 854, July 31, 1956, to correspond with the $12,500–$19,000 range for similar positions in other agencies

The chronology is shown in the following summary:

UNITED STATES ATTORNEYS

	Minimum	Maximum	
1923	$3,000	[1] $7,500	Act of Mar 4, 1923, 42 Stat. 1560.
1930		[1] 9,000	Classification Act pay schedules.
1945		[1] 9,800	
1946		10,000	
1948		10,330	
1949		11,000	
1951		11,800	
1953	10,000	15,000	Public Law 195, 83d Cong., Aug. 5, 1953.
1954		15,000	Public Law 471, 83d Cong, July 2, 1954.
1955	12,000	20,000	Public Law 9, 84th Cong., Mar. 2, 1955.

ASSISTANT UNITED STATES ATTORNEYS

1953	$6,000	$12,000	Public Law 195, 83d Cong.
1954		12,000	Public Law 471, 83d Cong
1955		15,000	Public Law 9, 84th Cong.

[1] United States attorneys for New York City, Chicago, and Washington, D. C., were paid $10,000 per annum under special authority.

G. Agency ceilings

Atomic Energy Commission.—The salaries of the members and certain other top executives in the Atomic Energy Commission are prescribed by statute or are authorized to be fixed up to a specified maximum above the Classification Act ceiling. The salary rates for other positions are not necessarily subject to the Classification Act or any other statutory schedule but are subject to certain maximum limitations prescribed in section 161d of the Atomic Energy Act of 1954, as amended.

Section 161d authorizes the Commission to "appoint and fix the compensation of such officers and employees as may be necessary to carry out the functions of the Commission. Such officers and employees shall be appointed in accordance with civil-service laws and their compensation fixed in accordance with the Classification Act of 1949, as amended, except that to the extent the Commission deems such action necessary to the discharge of its responsibilities, personnel may be employed and their compensation fixed without regard to such laws: *Provided, however*, That no officer or employee (except such scientific and technical personnel up to a limit of $19,000) whose position would be subject to the Classification Act of 1949, as amended, if such Act were applicable to such position, shall be paid a salary at a rate in excess of the rate payable under such Act for positions of equivalent difficulty or responsibility."

This provision (except for the limitation on salaries of scientific and technical personnel) appeared in Atomic Energy Commission appropriation items for many years before it was included as permanent legislation in the Atomic Energy Act of 1954. The $19,000 limitation on the salary rates for scientific and technical personnel was added by an amendment in Public Law 85-287, September 4, 1957.

Prior to the amendment in Public Law 85-287, section 161d of the Atomic Energy Act of 1954 gave the Atomic Energy Commission complete authority to fix rates for its scientific and technical personnel. The Commission had used this authority to provide top salaries for such employees as the Deputy and Assistant General Managers and the managers of certain field operations offices. When legislation was being considered to increase the salaries of top officials in the Atomic Energy Commission, the Joint Committee on Atomic Energy noted that the salary rates for these positions were to be specifically covered by amendments to sections of the Atomic Energy Act of 1954 other than section 161d. Therefore, they concluded that a limitation could properly be put on the maximum salaries payable to scientific and technical personnel under that section. The committee's report on the proposed legislation stated, "Although the committee recognizes that it is important to the successful operation of the Commission to be able to obtain first-rate scientific and technical persons, the committee believes that such persons should not receive salaries in excess of that of the program division directors, whose salary is to be a maximum of $19,000." [14]

[14] S. Rept. No. 790 on S. 2672 and H. Rept. No. 977 on H. R. 8994.

Public Law 85–287 did not affect the statutory limitation on the salary rates for personnel other than officers paid at statutory rates and scientific and technical personnel. No officer or employee whose position is of the kind normally covered by the Classification Act may be paid more than he would receive under the Classification Act in a position of equivalent difficulty or responsibility.

Farm Credit Administration.—In 1933 the Farm Credit Act established a ceiling of $10,000 on the compensation of any "director, officer, or employee of the central bank for cooperatives, or of any production credit corporation, production credit association, or bank for cooperatives."

In subsequent years, in connection with general pay increase measures, this ceiling has been lifted as follows:

1933: $10,000 (sec. 66, Act of June 16, 1933, 12 U. S. C., 1138f).
1949: $13,000 (sec. 1201, Classification Act of 1949).
1951: $13,800 (sec. 3, Public Law 201, 82d Cong., approved October 24, 1951).
1955: $14,620 (sec. 5, Public Law 94, 84th Cong., June 28, 1955).

International Cooperation Administration.—Section 527 (b) of the Mutual Security Act of 1954, Public Law 665, 83d Cong., August 26, 1954, limits to a maximum of 60 the number of officers or employees employed in the United States on authorized mutual security programs who may be paid without regard to the Classification Act.

Of these 60, not more than 35 may be paid higher than the scheduled maximum of GS–15 ($12,690). Of these 35, not more than 15 may be paid in excess of the highest rate for the general schedule (GS–18, $16,000) but not in excess of $19,000.

This, for the Foreign Operations Administration was a modified continuation of authority given the former Economic Cooperation Administration in 1948. The International Cooperation Administration succeeded Foreign Operations Administration under the provisions of Executive Order 10610, May 9, 1955.

The International Cooperation Administration is also authorized to administratively fix the salary rates for six additional positions. This authority was originally granted to the Foreign Operations Administration by Reorganization Plan No. 7 of 1953 and was transferred to the International Cooperation Administration by Executive Order 10610. The ceiling rate for these positions, as increased by the Federal Executive Pay Act of 1956, is $19,000.

Tennessee Valley Authority.—The Tennessee Valley Authority is not subject to the Classification Act or any other statutory schedule. The salary rate of members (other than the Chairman) of the Tennessee Valley Authority Board is fixed at $20,000 by the Federal Executive Pay Act of 1956. The rate for the Chairman is $20,500.

Section 3 of the Tennessee Valley Authority's organic act of May 18, 1933, established the Board members' salary rate as the agency ceiling. The law provides:

"The Board shall without regard to the provisions of Civil Service laws applicable to officers and employees of the United States, appoint such Managers, Assistant Managers, officers, employees, attorneys, and agents as are necessary for the transaction of its business, fix their compensation, define their duties, * * *. No regular officer or employee of the Corporation shall receive a salary in excess of that received by the members of the Board."

IV. LEGISLATIVE BRANCH

A. The Speaker of the House

Originally	[1] $12	1874	$8,000
1816	3,000	1907	12,000
1817	[1] 16	1925	15,000
1856	6,000	1946	20,000
1866	8,000	1949	30,000
1873	10,000	1955	35,000

[1] A day.

The Speaker's official compensation is $45,000 a year. Of this, $35,000 is salary and $10,000 expense allowance.

The pay of the Speaker of the House, originally $12 a day, was changed to an annual salary of $3,000 a year in 1816 and reverted to a daily rate, $16, the next year. It was raised to an annual salary of $6,000 in 1856, to $8,000 in 1866, to $10,000 in 1873, reverted to $8,000 in 1874 on repeal of the 1873 law, was raised to $12,000 in 1907, to $15,000 in 1925, to $20,000 in 1946, to $30,000 by Public

Law 2, 81st Congress, in 1949, and to $35,000 by Public Law 9, 84th Congress, in 1955.[15]

Public Law 2, 81st Congress, also provided the Speaker with an expense allowance of $10,000 a year. At first tax free, this allowance was made subject to income taxation in 1953.

B. Members of Congress

Prior to 1856	(1)	1933–34	$8,500
1856	(2)	1934	9,000
1866	$5,000	1934–35	9,500
1873	7,500	1935	10,000
1874 [3]	5,000	1946	[5] 15,000
1907	7,500	1949	[5] 15,000
1925	10,000	1955	22,500
1932–33 [4]	9,000		

[1] $6, $7, or $8 a day during attendance (except $1,500 a year in 1816–17).
[2] $6,000 for each Congress ($3,000 a year)
[3] In 1873 Congress increased the pay of top legislative, judicial, and executive officials (act of Mar 3, 1873, 17 Stat 486) The new rates, however, were repealed the next year, except for the President and Justices of the Supreme Court (act of Jan 20, 1874, 18 Stat (pt 3) 4)
[4] Economy legislation in the period 1932–35 reduced the salary rates of Members of Congress as follows: Public 212, 72d Cong., June 30, 1932, 10 percent from July 1, 1932, to Apr 1, 1933, Public 2, 73d Cong., Mar 20, 1933, as amended 15 percent from Apr 1, 1933, to Jan 31, 1934, 10 percent from Feb 1, 1934, to June 30, 1934, and 5 percent from July 1, 1934, to Mar 31, 1935
[5] Total compensation Includes a $2,500 expense allowance, which was tax free until 1953 when it was made taxable under the provisions of the Revenue Act of Oct 20, 1951 This allowance was discontinued, effective Mar 1, 1955, by Public Law 9, 84th Cong, approved Mar 2, 1955 For income-tax purposes, Members of Congress may deduct up to $3,000 a year for living expenses (26 U S C. Supp. IV 162 (a) (3)).

C Top officers of the Congress

Several laws and resolutions in the 84th Congress fixed new individual gross salary rates for some of the top officers of the Congress These current salaries are as follows:

Position	*Gross rate*
Senate:	
Secretary of the Senate	$17,500
Sergeant at Arms	17,500
Secretary for the majority	15,500
Secretary for the minority	15,500
Chief Clerk	15,500
Parliamentarian	15,500
Legislative Counsel	17,500
Senior counsels (3)	15,500
House:	
Clerk of the House	17,500
Sergeant at Arms	17,500
Parliamentarian	20,500
Assistant Parliamentarian No. 1	16,500
Doorkeeper	16,500
Legislative counsel	16,125
House minority clerk	15,000
House minority sergeant at arms	15,000
Postmaster	14,500
House minority doorkeeper	12,500
House minority postmaster	11,000
Joint:	
Chief of staff of the Joint Committee on Internal Revenue Taxation	17,500

D Committee staffs

The salary rates or ceilings for members of committee staffs and certain other employees under the Congress are usually expressed in laws or resolutions as "basic" rates. Their total or "gross" salaries are determined by adding specified percentages and dollar amounts to the "basic" rate.

The Legislative Reorganization Act of 1946, Public Law 601, 79th Congress, August 2, 1946, section 202 (e), fixed a "basic" salary rate of $8,000 as the ceiling for professional staff members of standing committees of the House and the Senate. This rate was the pre-1945 minimum rate of the highest scheduled grade of the Classification Act, CAF–15.

[15] Economy legislation effective in 1932–35 reduced the Speaker's compensation 15, 10, and 5 percent, successively, during that period.

Public Law 201, 82d Congress, October 24, 1951, section 2 (b), limited the "gross" salary of committee and most other legislative employees to $11,646 unless otherwise expressly authorized by law.

Public Law 94, 84th Congress, June 28, 1955, section 4 (b), changed the $11,646 ceiling to "the highest per annum rate of compensation paid under authority of the Classification Act of 1949, as amended," then $14,800. Since a "basic" rate of $8,000 computed to a "gross" rate of less than $14,800 ($14,638), the "basic" salary ceiling of the Legislative Reorganization Act of 1946 was raised from $8,000 to $8,820 in order to have it correspond to the "gross" salary ceiling of $14,800 permitted by Public Law 94.[16] (A "basic" salary of $8,820 computes to a "gross" rate of $14,836.)

In the closing days of the 2d session, the 84th Congress raised the highest rate of the Classification Act to $16,000, thereby increasing the "gross" salary ceiling for these legislative employees but not affecting the "basic" rate of $8,820. Thus the maximum "gross" salary which an employee can actually be paid is now $14,836 [17]

E. Other legislative agencies

The salary rates of the heads and assistant heads of several legislative agencies are fixed by the Federal Executive Pay Act of 1956. These are:

General Accounting Office.	
Comptroller General	22, 500
Assistant Comptroller General	20, 500
Government Printing Office.	
Public Printer	20, 000
Deputy Public Printer	17, 500
Library of Congress	
Librarian of Congress	20, 000
Chief Assistant Librarian of Congress	17, 500
Office of the Architect of the Capitol.	
Architect of the Capitol	19, 000
Assistant Architect of the Capitol	17, 500

V. JUDICIAL BRANCH

A. Federal judges

Year	District judges	Circuit or courts of appeals judges	Associate Justices of Supreme Court	Chief Justice of the United States
1789			$3, 500	$4, 000
1819			4, 500	5, 000
1855			6, 000	6, 500
1871			8, 000	8, 500
1873			10, 000	10, 500
1891	[1] $5, 000	$6, 000	(2)	(2)
1903	6, 000	7, 000	12, 500	13, 000
1911	(2)	(2)	14, 500	15, 000
1919	7, 500	8, 500	(2)	(2)
1926 [3]	10, 000	12, 500	20, 000	20, 500
1946	15, 000	17, 500	25, 000	25, 500
1955	22, 500	25, 500	35, 000	35, 500

[1] Until 1891 salaries of district judges varied in the several districts In that year a uniform salary of $5,000 was fixed (26 Stat 783)

[2] No changes

[3] The salaries of judges of the Supreme Court of the United States and other Federal courts were unaffected by the reductions which took place in 1932 to 1935 Art III, sec 1, of the Constitution provides that Federal judges' compensation "shall not be diminished during their continuance in office." Judges who took office on or before June 6, 1932, were not subject to income-tax laws until 1939. Those who took office after that date were subject to the Revenue Act of 1932 and subsequent tax laws (Public Salary Act of 1939, Public Law 32, 76th Cong , 1st sess)

[16] Sec. 12 of Public Law 242, 84th Cong , August 5, 1955 This same act provided that only 1 employee of each standing or select committee of the Senate and of each joint committee of the 2 Houses, the expenses of which are paid from the contingent fund of the Senate, may be paid a basic salary as high as $8,820

[17] Public Law 242, August 5, 1955, limits the gross salary for employees of Senate committees to $14,800.

B. Administative Officer of United States Courts

The salary rates of the Director and the Assistant Director of the Administrative Office of the United States Courts under the Federal Executive Pay Act of 1956 are $20,000 and $17,500, respectively.

C. Commissioners of the United States Court of Claims

The pay of the Commissioners of the United States Court of Claims is fixed under the Federal Executive Pay Act of 1956. Prior to that act their rates were established by the Executive Pay Act of 1949 and increased by Public Law 201, October 24, 1951.

1949	$14,000
1951	14,800
1956	19,000

There are now 12 such Commissioners.

The salary rates of the judges of the court have been as follows:

1946	$17,500
1955	25,500

D. Referees in bankruptcy

The pay of full-time and part-time referees in bankruptcy is limited by maximum rates established by section 40a of the Bankruptcy Act of July 1, 1898, as amended (11 U. S C. 68 (a)).

The Referees' Salary Act of 1946 raised the limit to $10,000 for full-time referees. In 1952 this was increased to $12,500 in relation to the $15,000 salary of Federal district judges

After the salary rate for Federal district judges was raised to $22,500 by Public Law 9, effective March 1, 1955, Congress passed legislation raising the maximum rate for full-time referees to $15,000 and that for part-time referees to $7,500 (Public Law 518, May 10, 1956). The precise salary of a given referee is determined by the Judicial Conference of the United States after advising with the judicial councils, district court judges, and the Director of the Administrative Office of the United States Courts. The law requires that in fixing the amount of salary to be paid a referee, consideration shall be given to the average number and types of, and the average amount of gross assets realized from, cases closed and pending in the territory which the referee is to serve, during the last preceding period of 10 years, and to such other factors as may be material. Disbursement shall be made monthly by or pursuant to order of the Director.

There are now 88 full-time and 75 part-time referee positions.

Customarily, referees' clerks and stenographers are included when pay increases are enacted for the Federal service generally, however, the referees themselves are not usually covered.

The CHAIRMAN. The next witness is Dr. B. Litman (doctor of philosophy), project head, inertial equipment, American Bosch Arma Corp.

STATEMENT OF B. LITMAN, PH. D. PROJECT HEAD, INERTIAL EQUIPMENT, AMERICAN BOSCH ARMA CORP.

Dr. LITMAN. I have a rather short prepared statement, Mr. Chairman.

What I would like to talk about today is the area of guidance and control.

Any problem of navigation essentially has to answer two questions at all times:

1. Where am I?
2. Where am I going?

The possibility of answering the first question hinges on the existence of a fixed reference system, such as landmarks over solid earth or geographical coordinates at sea.

As to the second question (again taking navigation upon the earth as an example), it is necessary to define a reference direction, such as

true north, and compare this northerly direction with the direction of velocity of the vehicle.

Inertial guidance as applied to vehicles traveling the earth utilizes equipment which first of all monitors fixed directions with respect to which we measure our motion.

This is accomplished by what is called an inertial platform, i e., a physical structure continuously kept in a fixed angular direction in space by reference to a set of gyroscopes mounted on the platform. Gyroscopes have the property of maintaining a fixed direction in space with great accuracy when they are properly designed.

In order to determine one's position, the vehicle's acceleration (i. e., change of velocity with time) is sensed. A set of accelerometers is mounted on the inertial platform; these provide information about the vehicle acceleration as seen in the principal directions of our reference system. These data are continuously fed to a computer which calculates vehicle velocity and vehicle position as a function of time.

The principles just mentioned represent a simplified picture of reality and in actual equipment the situation is more involved. Suffice it to say that an inertial navigation system, by its very nature, is self-contained, since no exchange of energy of any sort (like radio waves, optical sighting, et cetera) is required with the outside environment.

Because of this feature, its operation cannot be detected by an external observer. It cannot be jammed, disturbed by weather conditions, or its accuracy impaired by countermeasures.

All that is required to navigate and/or guide a vehicle in a precise and reliable way is to have high precision components, together with a supporting technology which is presently available and common for all navigation and guidance systems.

During the past years, considerable improvement in performance of inertial equipment has been achieved. As a result, it has become possible to construct and successfully test an array of inertially guided vehicles of all sorts, ranging from surface ships to inertially guided long-range missiles. The industry currently is turning out equipment of smaller size and weight, greater reliability and flexibility, and having a broader applicability.

Application of inertial principles to space flight raises specific problems of its own, partly because the environment of operation is not known with sufficient certainty, but mainly because of three fundamental conditions prevailing in outer space not encountered in applications of surface navigation.

These new elements are:

1. The length of duration of navigation, which causes the unavoidable imperfections of components to result in velocity and position errors. These errors accumulate at a high rate, as the duration of flight increases.

2. The trajectory to be followed by the vehicle in interplanetary flight (from the earth to the moon or again from the earth to keep a rendezvous with a manmade satellite) has to be followed very precisely and should be clearly defined and expressed in appropriate space coordinates. Not only should the trajectory be followed precisely for a successful mission, but the timing along said trajectory should be held within very close tolerances.

3. Since the powered portion of any long-distance space flight is but a small portion of the overall trajectory covered, the unpowered por-

tion of flight is featured by a so-called free fall behavior (although there is no "fall" in the usual sense of the word). This results in an apparent gravity-free environment in which the accelerometers continuously sense zero acceleration.

On account of item 3, it would seem that inertial guidance applied to space vehicles is of no value except during takeoff and landing, when powered thrust is applied. Actually, as a result of extensive studies conducted in this field, it appears that an appropriate instrumentation composed of basic inertial components should overcome the difficulty just mentioned.

The method is essentially based on the measurement of acceleration differences prevailing at any instant between any two opposite ends of the space occupied by a vehicle, while the center of the vehicle itself experiences no apparent acceleration. Thus as we approach one of the planets, there will be a rapidly converging gravity field (converging toward the center of the planet) and we will see differences in the acceleration force sensed by the two accelerometers.

Knowing the distance between accelerometers thus provided, the output difference of these accelerometers offers the information desired. Having separated the gravity component from the true acceleration components, the techniques worked out for inertial navigation upon the surface of the earth can be extended without major modifications to the problems of space travel, especially in the vicinity of either the earth or a planet.

The components and techniques pertaining to this type of navigation are within our reach, and any company already engaged in inertial instrumentation should be able and qualified to undertake successfully the building of inertial instruments for space navigation.

This result is but one of the few important breakthroughs that present-day engineering efforts have managed to accomplish. Other navigation schemes will utilize celestial observations or other methods in combination with inertial equipment

In all cases, we find that inertial help is required if only for the purpose of introducing small correcting thrusts for trajectory corrections and monitoring the amount of the correction which has been introduced.

The continued study of similar techniques and development of better hardware is in progress today both as part of continuing efforts in land navigation and forthcoming applications to space travel. There is every indication that the rate of progress in the past will be maintained in the future so that we may look forward to continued improvement and innovations in the application of inertial guidance to space travel.

These improvements will also be of direct use for many of the more conventional earthbound methods of travel.

This little model is perhaps a little bit complex to go through all the details. I might say it has proven of use even for our own engineering people in designing systems.

It shows a structure which will enable the central package to stay in a fixed direction in space in spite of the maneuvering of the satellite or other space vehicle. We indicate on it the gyros which will hold it rigidly in space; the accelerometers which are used to sense the acceleration, and hence, determine the actual movement of the platform.

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This does not show actual working details which in our present work is, of course, classified. But this does give a fair idea of what such platform will look like.

I think we can say the general order of magnitude of the size is not out of line with what we would actually have.

If there are any questions, I would be happy to discuss them.

Mr. HAYS. I have a question, Doctor Litman, first in semantics. I want to understand the word "inertial."

Dr. LITMAN. Well, we utilize this word because any inert mass—anything we have in this world—has mass. Any such body when you accelerate it, when you change its speed, experiences a force. For example, when you are driving a car, you know that when you apply the brakes there is a force on your body. Any body will experience such a force

We can say that the force is proportional to the acceleration, or proportional to the rate at which we are changing speed. This is the basic idea we utilize. We measure such a force in the device we call an acclerometer.

This tells us how fast our speed is changing. From this we can proceed to do some computations and decide how fast we are going and how far we have traveled.

Mr HAYS Then inertia has reference to condition of an object as to whether it is in motion?

Dr LITMAN. Yes; I would say you could describe it that way.

It is just the fact that any object requires a force to bring it up to speed. Any object has inertia, and inertia is a property which says that to speed it up you have to push on it or apply force.

Mr. HAYS. Would you call this a vehicle?

Dr. LITMAN. We refer to this as an inertial platform. It is actually our sensing unit which determines how the satellite or space vehicle is moving.

Mr. HAYS And that is not something designed to go into space itself?

Dr. LITMAN. Yes; this would be placed within the space vehicle. It would travel with it as a self-contained navigation system in the space vehicle. It would continuously put out data saying how fast or how far we have gone.

Mr McDONOUGH. This is a guidance system?

Dr. LITMAN. This would be the guidance system; yes.

Mr. McDONOUGH. Stabilizer?

Dr. LITMAN. Yes; it is in a sense a stabilizer.

This data that it puts out would be used then to control space vehicles, to steer it in the right direction, and to carry it to the right point in space.

Mr. McDONOUGH Would the gentleman yield?

Mr. HAYS. Yes, I do.

Mr. McDONOUGH. In what do we use this type of stabilizer at the present time; in a surface vehicle?

Dr. LITMAN There have been applications of inertial guidance equipment to shipboard use; a number of different aircraft applications; and many of the modern long-distance missiles, including the ballistics missile

I do not think I can refer to specific applications. Most of the present-day applications have been military so far.

Mr. McDonough. In other words, there is no surface vehicle that rolls on wheels that needs this kind of a system?

Dr. Litman. In the case of a vehicle that goes on wheels, we have a somewhat easier problem. We can count the revolutions of a wheel just like the speedometer in a car will give total distance traveled.

Now, actually we have a somewhat similar package which is used for wheeled vehicles. The Army utilizes it. We do not have to sense the accelerating forces, but just the revolutions of the wheel.

We have to combine this, though, with some direction reference so we know whether we are going north or east. And we have to combine this and a small computer to tell us where we have traveled. There is a somewhat similar package which has been developed and is being used—a land navigation system.

The fact that you do have wheels simplifies the problem quite a bit.

Mr. McDonough. In only one direction and that is up and down. And this would be up and down and forward and back as far as its stabilizing effect is concerned.

It would affect the vehicle going up and down and forward and back, would it not—this instrument would?

Dr. Litman. This one would have effects in all directions.

It tells motion in all three directions.

Mr. McDonough. Just to get my mind clear on its comparative use on a land-operating wheeled vehicle, do the snubbers or stabilizers on an automobile that allows the body to move up and down easily over bumps have a similarity to this insofar as its up and down operations are concerned, or to a vehicle in the air?

Dr. Litman. No; not really. The snubbers are just a means of, say, damping or limiting motion of an automobile. They do not actually sense the total amount of the motion and compute how far we have gone up or down.

Mr. McDonough. That is right.

Dr. Litman. The inertial guidance system will actually sense these accelerating forces and use them to compute how far we have traveled, again up, as well as in a sidewise direction.

Mr. McDonough. Then the ultimate purpose of this is for straight, level flight?

Dr. Litman. Not necessarily for straight flight. It can be used for any types of maneuvers at all. If you want to go in one straight direction, you have to have some means of telling that you are going that way or not veering off to one side.

If you wish to go in a curved path—and here we can take as an example the satellites we have launched, which are first shot upward to the air and tilted over to get some circular velocity—the same system controls all those velocities; it controls the vehicle so that it acquires just the right motions in all directions.

We have to make slightly different provisions, depending on the purpose of the vehicle, whether it is to go on level flight or go into an orbit, perhaps to go to the moon. But the basic mechanism would always be the same, the means of sensing which way it is going in space.

Mr. McDonough. We haven't used this type of stabilizer on the satellites we have shot up to now, have we?

Dr. Litman. They have utilized a rather crude version of this. They have utilized some of the similar principles.

Mr. McDonough. Is this a patented article?

Dr. LITMAN. Yes. Much of the developments in this article are patented. The detailed items, generally, are all still classified. And most of the applications are for such items as our long-range ballistic missiles.

Mr. McDONOUGH. This is a product of American Bosch Arma Corp.?

Dr. LITMAN. That is correct.

Mr. McDONOUGH. For how large a vehicle could this act as a stabilizing unit in space flight? Would you have to build a bigger one than that for——

Dr. LITMAN No. The size of the vehicle is independent of the size of this guidance package. We, in fact, are striving—and other companies, in the field, similarly, are striving—to make smaller packages, so that they represent less weight and will not be any burden to lifting a payload into outer space.

The fact that it is smaller does not mean that it has any difficulty controlling a larger vehicle The controls of the vehicle are, for example, the engine nozzle, which will cause the engines to apply thrust in different directions

Mr. McDONOUGH. One last question: Is this completely automatic? You have dials to indicate these different motions, I suppose?

Dr. LITMAN The present use, of course, for example, on a ballistic missile is for an unmanned vehicle. Similarly, for the earth satellites. So, here we do have a completely automatic package. There are, in fact, no dials, since there is no one up there to read the dials. The information is used directly to steer the engines.

Mr. McDONOUGH. In a manned vehicle, would this be completely automatic?

Dr. LITMAN. In a manned vehicle, we would plan for this to be completely automatic since, the motions in taking off and landing are so rapid that they are really beyond the capabilities of a man to operate them. There would, in addition, be dials which he could look at so he would know where he is. But he would not have to, say, handle a steering wheel. This would all be done automatically.

The CHAIRMAN Mr. Hays?

Mr. HAYS. That is all I have.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Natcher?

Mr. NATCHER. I have no questions, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. I have no questions.

The CHAIRMAN. Mr Ford.

Mr. FORD. I have no questions.

The CHAIRMAN. Thank you very much, Dr. Litman. We are glad to have you before us We appreciate your testimony. Thank you very much.

Mr. LITMAN. Thank you.

The CHAIRMAN. The next witness is one of our colleagues. We are glad to have you before us, Congressman Harry G. Haskell, Jr., of Delaware. We are very glad to have you appear before us.

STATEMENT OF REPRESENTATIVE HARRY G. HASKELL, JR.,[41] OF DELAWARE

Mr. HASKELL. Thank you, Mr. Chairman. It is a pleasure to have this opportunity to testify before you today on this National Aeronautics and Space Agency.

During the past 2 years, I have been working with a team of 5 men on aviation's present problems and its future potential.

Last December, in a speech at the Franklin Institute in Philadelphia, I proposed the establishment of a national long-range program of research and study on the future utilization of airspace for peaceful purposes. Following that speech, Mr. Quesada, Chairman of the Airways Modernization Board, formed a panel of 12 extremely able and experienced aviation people to study that proposal.

The recommendations of these consultants to establish such a research program were presented to Dr. Killian, special assistant to the President.

Is there a need for civilian research agency? Research by the military in these areas must go forward at top speed, and there is no intent whatsoever in this legislation to have a new civilian agency direct military research efforts.

What is contemplated is an agency which can carry on research into the aspects of flight that have peaceful and scientific uses, and can work with and assist the military. As the military proceeds with its research, we would have a strong civilian research organization which could make use of knowledge developed by the military that has peaceful and scientific application, and an organization which could carry on flight research that does not directly interest the military.

It is realized that most of the testimony to date has been on space matters and the technical problem of how we can get a man to the moon. However, this proposed legislation is directed at research into the problem of flight within the earth's atmosphere, as well as space, and it is not limited to purely technical research on the problem of flight. These two very important points must not be overlooked, and I would like to direct my testimony to them.

There are two major areas of research on the problems of flight which will require extensive efforts.

First, there is the need for research into the purely technical problems. This is research to establish new technical capability. This research would deal with the vehicles, propulsion, equipment, and scientific know-how to enable man, physically, to use air and space.

Second, there is an urgent need for long-range research and study of nontechnical matters, such as the economic, legal, regulatory, and allied aspects of the advances in technical capability which will be made. As we develop new technical capability, we must undertake studies and research to see how it can be used and what problems it will create. For example, what will be the economic, legal, and

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[41] Haskell, Harry Garner, Jr., Congressman, b Wilmington, Del, May 27, 1921, s Harry Garner and Elizabeth (Denham) H , student pvt. schs , student Princeton, 1940–42, m Mary Carey Foster, May 3, 1947, children—Malcolm Wells, Christopher Denham, Laurie Amory, Mary Carey, James F Personnel mgr. Speakman Co , 1947–48, pres Greenhill Dairies, Inc , 1948–53, sec departmental council Dept. Health, Edn. and Welfare, 1953–55; cons spl projects Office Nelson A Rockefell, 1955; mem. 85th Congress, Del Dir. Wilmington Trust Co , Brown & Scott Packing Co , Garrett, Miller & Co Del. Republican Nat. Conv., 1952; treas. New Castle County Young Republicans Treas. U. Del. Research Found , dir. Fisk U., Del chmn Crusade for Freedom Served as lt (j g) USCGR, 1942–45. Episcopalian. Home: 1001 Berkeley Rd., Wilmington, Del. Office House Office Bldg , Washington

regulatory problems involved with new types of aircraft, satellites, new communications channels, weather operations, and the like. How can we control this new technology safely and efficiently?

On the problem of technical research, I have no competence whatsoever. On the other research areas, however, I do have some thoughts and ideas.

All the technical developments you can imagine might well be of little or no use to man if we do not simultaneously go to work on developing the means for him to utilize them and control them.

Our present national aviation program, unfortunately, provides solid evidence of how we have permitted our technical capability to outstrip our ability to use it fully, to control it, and to solve other related problems. Let me give you some specific evidence on this point.

The serious difficulties we are experiencing today in aviation are familiar to all of you. It is a fact that our air traffic control system is not nearly as safe or efficient as it should be. It is also a fact that we cannot make full utilization of even our present aircraft capability, and experienced persons in aviation today feel that we are years behind in this regard.

With respect to safety, the recent disastrous midair collision in Nevada was no surprise to anyone familiar with the situation. We have been experiencing about 3 or 4 near collisions in the air every single day, and it would take only about 6 collisions involving 2 airliners to exceed the accident rate of automobile travel.

With regard to efficiency, our inadequate air traffic control system is now costing the country about $60 or $70 million a year in delays of military and commercial aircraft.

But perhaps the most serious problem for all of us is the inability of the military to utilize fully its aircraft capability in the defense of the country. The information I have on this matter demonstrates the imperative need for research and study on control methods and the means of utilizing technical advances as they are developed.

Mr. Chairman, I believe this information bears directly on the deliberations of this committee.

Over the past 6 months, at my request, the Air Force and the Navy have provided me with 19 official reports on these aviation defense matters containing more than 120 pages of detailed information. Some of this information is secret; much of it is classified; and all of it is specific documentation of the critical military preparedness problems we face with respect to our airpower.

This brown envelope contains the classified reports to which I refer. While the reports are classified, I can discuss certain facts from them.

The reports make it unmistakably clear that our military preparedness against possible enemy attack is being seriously limited by our present inability to utilize fully the technical developments in our military aircraft.

First, active air defense scrambles to intercept unidentified and potentially hostile aircraft near or over the United States are severely delayed because our fighters are forced to fly rigid, roundabout courses from their bases to the unidentified bogeys.

Second, adequate combat training of Air Force and Navy pilots is seriously curtailed because operations at some of their bases are almost completely shut down under instrument flying conditions.

Third, the difficulty of controlling missile tests results in some tests being canceled and others being prohibited entirely because we cannot provide adequate clearance and safety for them.

Fourth, collisions and crashes of military aircraft amount to millions of dollars annually.

I want to emphasize that today these problems are not the fault of the Air Force, the Navy, or the Civil Aeronautics Administration which handles all military and civilian air traffic. All these organizations are working under the most extreme hardships, and are doing the best possible job with the equipment and the funds provided.

One of the most serious of these military situations is the limitation on our air defense and the use of our air defense interceptor aircraft. Every time the North American Air Defense Command launches an active air defense scramble under instrument conditions to intercept an unidentified and potentially hostile aircraft, the pilots of those fighters are delayed an average of 7 minutes and sometimes the delay amounts to as much as 20 minutes.

Mr. Chairman, according to the reports I have, there are 520 active air defense scrambles a month, and these delays represent an incredible situation. Most of us have always assumed that our fighters had a clear track after takeoff to get to the point of intercept as quickly as possible. That is not the case.

A 7-minute delay means that an enemy plane could get at least 70 miles closer to any one of our major cities.

A 20-minute delay would bring an enemy bomber 200 miles closer to its target. As you all know, with enemy planes today capable of delivering a hydrogen bomb attack, it does not require hundreds of planes to inflict terrible damage on us. A few bombers slipping through our air defenses on a sneak raid could cause millions of casualties. As General Power, commanding general of the Strategic Air Command, has said, "One enemy bomber can destroy one American city."

Let me describe a specific situation in more detail. In Delaware, we have had two fighter-interceptor squadrons assigned to help protect one of the most populated areas in the country along the Atlantic coast.

Every time an active air defense scramble was ordered at the New Castle Air Force Base which is now closed, the pilots had to detour on a prearranged course about 40 miles from a straight line to their targets to avoid the risk of collision with the heavy commercial and private airplane traffic flying on nearby airways.

This 40-mile detour represented about a 7-minute delay, and, of course, greatly reduced the range of the fighters by making them use up large amounts of fuel. The same type of situation exists at our other air defense base at Dover.

At Otis Air Force Base in Massachusetts, delays of scrambles at times amount to 20 minutes.

Mr. Chairman, I have proof in these reports that this situation exists at many locations throughout the country. While the CAA is trving to improve this situation, it has existed for a long time and it still operates this way.

What is most serious of all is the documented fact that in some cases our air defense fighters were completely unable to intercept unidentified and potentially hostile aircraft approaching the United States because they could not take a direct, immediate route to the target. I have specific details of these incidents in my possession.

A situation almost as serious in regard to our military preparedness exists in the limitations on the training of combat-ready fighter pilots and strategic bomber crews.

I have here a special report from the Strategic Air Command which shows that in 1957 SAC lost 2,160 hours of flying when they were prevented from getting their planes in the air because of heavy air traffic.

These 2,160 hours which were lost amount to the time required to train 11 B-47 crews from scratch. Last year, SAC had a net increase of only 55 crews brought up to combat-ready status from scratch.

In terms of maintaining the proficiency of existing SAC crews, these flying hours lost amounted to the time required to keep 142 B-47 crews at a fighting level. This command, it must be remembered, is our chief deterrent fence.

The Navy aviation problem in maintaining proficiency of its pilots is perhaps even more severe. One of the official reports from the Navy describes the situation as follows:

> As an average, naval air stations supporting the Atlantic Fleet can be expected to reduce operations to one-third or one-fourth under instrument conditions due to the delays and limitations of the air traffic control system. At least one station drop to a level far below this average.

I have reports containing specific information from each naval airbase on the cancellation of training missions.

Any loss in training to maintain combat readiness must be considered time lost forever. If an attack should come, we will have to fight with what we have ready to fight. There will not be time, as in previous wars, to hold off an enemy from our shores until we are trained to do the job.

We have received only a little information so far about the present or potential limitations imposed on missile tests by our air traffic control system. At one Navy test center, the report delivered to me shows that in a 3-month period, 72 missile tests were canceled because adequate control clearance could not be obtained. In 1 month the cancellations amounted to about 10 percent of the operations.

The contemplated testing of missiles over areas of the continental United States certainly raises all sorts of serious problems.

This training at actual missile defense sites near cities, according to Dr George E Valley, chief scientist of the Air Force, is essential to our combat readiness. How to provide a clear route through normal air traffic will be difficult to do, to say the least.

Finally, the losses to the Air Force from midair collisions and crashes are staggering. The Strategic Air Command in 1957 alone had 3 crashes which they attribute in whole or in part to the lack of an adequate air traffic control system which resulted in losses totalihg $11,420,000

These problems all stem from our inability to handle the technical capability of our aircraft. Our control systems have not kept pace with the development of faster and better airplanes.

We must not fail to learn from the experience we are going through today. It seems to me that these facts underline all too seriously the importance of conducting long-range studies on how we will handle new technological advances in flight both within and outside of the earth's atomsphere.

I cannot urge you too strongly to incorporate in this proposed legislation provision for long-range studies that will analyze the

problems and the opportunities which our technical advances will create.

Therefore, I would like to propose the following amendment to the draft bill which has been submitted to this committee. We have discussed this amendment with appropriate agencies in the Government including the Bureau of the Budget, and they have no objections to the inclusion of this amendment.

On page 2, line 18, insert the following:

(4) the establishment of long-range studies into the potential benefits to be gained from, the opportunities for, and the problems of utilizing manned and unmanned flight for peaceful and scientific purposes.

I believe that this new Agency would be the most appropriate organization to sponsor these studies, because the studies would be directed by the Agency which is conductong the technical research and close liaison could be maintained.

Thank you, Mr. Chairman, for the opportunity to present these views to this committee. I will be happy to supply, under appropriate security measures, any additional details on this military information that you may want.

The CHAIRMAN. Mr. Hays.

Mr. HAYS. Thank you, Mr. Chairman. I would say to our colleague that we appreciate his contribution to our thinking. We are glad to have you here. Mr. Haskell, you have introduced a bill on this subject?

Mr. HASKELL. I introduced a companion measure to this; yes.

Mr. HAYS. Is it in the same form as the chairman's bill?

Mr. HASKELL. Yes; it is.

Mr. HAYS. So, the amendment you propose would have to be added? In other words, it is not in the text of your bill?

Mr. HASKELL. No; it is not. It would have to be added.

Mr. HAYS. Thank you. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. I have no questions, Mr. Chairman. But I want to thank our colleague, Mr. Haskell, for his appearance before our committee today.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. No questions.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. I appreciate your appearance here today, Mr. Haskell. I think you have made a very good point. We certainly can't apply too much research and study to the question of air traffic to create safety and to provide for additional military defense. I have no questions. I appreciate what you have said, though.

Mr. HASKELL. I used the air traffic control as an example of what we should have done in times past.

Incidentally, Prof. John Cooper was one of the members of our group who worked on this who I believe testified before you this morning.

The CHAIRMAN. Well, you have certainly addressed yourself to one of the most serious and challenging questions that confronts us—the question of air control. I have been very much interested in it for several years. I can see the development of military necessities and civilian necessities. I have often been interested in the reconciling of them rather than having conflicts, but to reconcile them to the advantage of our people both from a civilian and from a military angle.

It is a very serious problem. You have addressed yourself to a very challenging problem to Congress and to our people. You said you discussed the amendment with appropriate agencies in the Government including the Bureau of the Budget. Could you state for the record what agencies you discussed your proposed amendment with?

Mr. HASKELL. Yes. I checked with the National Advisory Committee. I checked with Jimmy Pyle of the CAA; with General Quesada of the Air Modernization Board; and with Dr. Killian's office.

The CHAIRMAN. You have done a lot of work. Are you satisfied that this language, if incorporated into the bill, would give this new Agency the authority to look into this field?

Mr. HASKELL. Yes, sir; I think it would make provision in the policy statement to go into long-range research, to look ahead.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Just one question on one slight point. You stated the "establishment of long-range studies." Do you want to change that to "the establishment of continuous studies"?

Mr. HASKELL. Well, I would hate to change the language after going through all of those organizations. But I think the word "long-range" is pretty critical in my estimation. One thinks of fundamental research, basic research, as other substitute words. But we really are thinking in terms of long-range continuous studies.

That would be O. K. But I would not want to lose the word "long-range." Because I think that is a key word in what I am talking about.

The CHAIRMAN Well, wouldn't the establishment of studies include both immediate and long-range?

Mr. HASKELL. Conceivably it could. But my emphasis in this testimony is to point up the need for long-range studies looking ahead. Rather than say applied research or short—well, maybe it is semantics we are arguing about here.

Mr. FELDMAN. That is all; yes.

Mr. HASKELL. But the main thing to do is to look ahead and get the most competent people we can get to do these kinds of studies.

Mr. FELDMAN. In other words, spread the immediate and long-range studies?

The CHAIRMAN. Wouldn't the establishment of the studies include both? I would think so, Congressman.

Mr. HASKELL. It would include both.

The CHAIRMAN. Long-range might be considered as a limitation in case they felt that the matter should be looked into in the near future.

Mr. HASKELL. Let me put it this way: I think that long-range can be interpreted from 1 minute from now on up.

I would like to leave the emphasis on looking way ahead on this problem rather. I am sorry to disagree with you.

Mr. FELDMAN. We are not disagreeing; we are just exploring.

The CHAIRMAN No, not disagreeing. I am asking these questions to try and make your language stronger, the effects of it stronger in operation.

Mr. HASKELL. I appreciate that.

The CHAIRMAN. I just want to get your opinion, because "long-range" might be a direction that they could really take up studies in research in this field 2, 3, 5, 10 years off. Whereas, there is a solution to an immediate problem called for, isn't there?

Mr. HASKELL. Well, yes. I feel that the emphasis should be, though—when these people let out contracts on future work that is going to lead them into fields—if there is a scientific breakthrough somewhere, then we do a study on something that is going to happen some period of time ahead.

And if we can come up with a study that indicates that a problem is going to happen 5 years from now, then we do something about it now. And I am not really arguing against you. I am just—I still feel I would like the emphasis on the "long-range" because this is the—I think all the consultants feel that this is where the emphasis should be placed.

Mr. SISK. Apparently the word "long-range" is the significant word in your amendment to use. Is that right?

Mr. HASKELL. Well, it is to me.

Mr. SISK. Of course, as you know, now included in the bill down at the bottom of page 5 under "Functions of the Agency" is the following:

> To plan, direct and conduct the scientific studies and investigations of the problems of manned or unmanned flight within or outside the earth's atmosphere with a view to their practical solution.

Now, would you make the comparison with that language as against the language you have proposed here to be added to the policy statement?

Mr. HASKELL. I think you could carry out these functions within that language.

I think we are talking about the same one.

Mr. SISK. I am referring to the bottom of page 5, under the second section there, where the "Functions of the Agency" are set out. I was curious to determine what broader basis for study or broader direction you would assume to be included in your proposed amendment, as against what actually amounts to the spelling out of the function of the agency in the present bill.

Mr. HASKELL. I personally would not object to putting it in the function area, more or less similar verbiage, if you chose to do that.

It would strengthen what I would be trying to do. So, you are right in that suggestion.

Mr. SISK. I actually was not proposing necessarily to change and put it under the functions. As I understand this, you propose this as part of the policy?

Mr. HASKELL. That is right.

Mr. SISK. The point I had in mind was what more would the language that you propose do in the way of spelling it out?

Mr. HASKELL. I would say that I think you can do it within the function area. I would like the emphasis in the policy area so that the intent of Congress would show to the NACA and the board who are going to be directing these long-range studies that this is the intent of Congress that they do these long-range studies.

Mr. McDONOUGH. Let me say that I appreciate your point of view and your interest in this very much, Mr. Haskell. And insofar as the use of words in describing the intent of yourself and others whom you have consulted, if your amendment read "the establishment of continuous long-range studies"——

Mr. HASKELL. That would be fine.

Mr. McDONOUGH. Instead of "the establishment of long-range continuous studies"—"continued long-range studies" would carry out the intent of your bill.

That means that the purpose and intent is to study this thing out and get a long-range study started immediately.

Mr. HASKELL. I think you should take it either way. I would like to see the studies carried on continuously.

Mr. McDONOUGH. Yes.

Mr. HASKELL. I am not sure you would necessarily keep the same project going if you exhausted its possibilities.

The CHAIRMAN Now, if you put this in the declaration of purposes, would the language over on page 5 that Mr. Sisk was calling attention to—the language on page 5, of course, means to "plan, direct and conduct scientific studies and investigations of the problems of manned or unmanned flight within or outside the earth's atmosphere with a view to their practical solution."

Mr. HASKELL. That is broad enough, I think, to get the policy under it.

The CHAIRMAN. That means immediate and continuous.

Now, if your language is put into the declaration of purposes—I realize that your language may not come necessarily within the purview of this.

Mr. FELDMAN. It could be a substitute provision, and more properly belong in the text of the law itself.

Mr. McDONOUGH. Yes. Rather than the policy.

Under the title of "Functions" rather than "Policy." But you say to refer to it in "Policy" and put it in the law also?

Mr. HASKELL. I would be willing to have it in both. I think you can accomplish your objective if you put it in the "Policy." You could probably accomplish your objective if you put it just in "Functions."

Mr. FELDMAN. From the point of view of draftsmanship, you could refer to it possibly in the "Policy" and then set out the substantive provision where it belongs, under the "Functions."

Mr. HASKELL. You probably know more about that than I would.

The CHAIRMAN. Well, coming back again to "long-range": we have "the establishment of continuous studies." I can see that.

Mr. McDONOUGH. Continuous studies could be studies not of a long-range nature. But "continuous long-range" studies would be continuously looking forward to bettering the safety of air traffic.

That is my interpretation.

Mr. HASKELL. Yes. Of course, I am not just talking about air traffic here.

The establishment of "long-range" studies and potential benefits to be gained for the opportunities for and the problems of using manned and unmanned flight. The whole shooting match.

Mr. McDONOUGH. That is right.

I do not mean air traffic alone.

The CHAIRMAN. Well, why don't the provisions of page 5 cover what you have in mind?

Mr. HASKELL. I think it is conceivable that they do.

But I would like to keep the emphasis as a result of my language in the policy declaration. So that as you carry out the functions on page 5, there is that sense of direction given to the new board.

The CHAIRMAN. Yes. But if you put this in the policy declaration, it might then be connected up with the language in page 5 and treated as a limitation of the language in page 5.

In other words, page 5 doesn't provide for long-range—"plan, direct and conduct long-range scientific studies."

Mr. HASKELL. If you feel it is a limiting thing, I would suggest that you take almost this same verbiage and put it in as No. 3 or an extra number in "Functions."

Mr. FELDMAN. Professor Cooper made this suggestion.

I just went down to see him.

Turning again to section 6 (a) under "Functions":

(1) Develop a comprehensive program of research in the aeronautical and space sciences;

And this is what would be added:

And other subjects consistent with the declaration of policy in section 2

Mr. HASKELL. I think that would be just the place for it if you were going to put it in, right there.

And I would not object to what Professor Cooper has to suggest.

In fact, I would welcome it.

The CHAIRMAN. We all compliment you for this research work you have done and the study you have given to it.

And we compliment you on your whole presentation this afternoon.

My only concern was that I didn't want to find by inserting it we are eliminating the agency in certain respects.

Mr. HASKELL. I wouldn't want that either, Mr. Chairman.

The CHAIRMAN. We thank you very much for your presentation, Congressman Haskell.

Mr. HASKELL. Thank you very much, Mr. Chairman, and members of the committee.

Mr. FULTON. May I add my compliments to your statement, Mr. Haskell.

Mr. HASKELL. Thank you.

The CHAIRMAN. Mr. Keating, did you want to ask any questions?

Mr. KEATING. No. Only to compliment Mr. Haskell on his statement.

The CHAIRMAN. The committee will have a short executive session.

(Whereupon, at 4:30 p. m. the committee proceeded into executive session.)

ASTRONAUTICS AND SPACE EXPLORATION

THURSDAY, MAY 8, 1958

HOUSE OF REPRESENTATIVES,
SPECIAL SELECT COMMITTEE
ON ASTRONAUTICS AND SPACE,
Washington, D. C.

The committee met, pursuant to call, at 10:25 a. m., in the caucus room, Old House Office Building, the Honorable John W. McCormack (chairman of the committee) presiding.

Present: Representatives McCormack, Keating, Fulton, Natcher, McDonough, Ford, Brooks, Hays, O'Brien, Metcalf, and Sisk.

The CHAIRMAN. The committee will be in order.

The first witness is Mr. Andrew Haley, president of the International Astronautical Foundation.

We are very glad to have you appear as a witness, Mr. Haley.

Do you have a prepared statement?

Mr. HALEY. Yes, I have. I think it has been distributed to the committee.

The CHAIRMAN. You may proceed, Mr. Haley.

STATEMENT OF ANDREW G. HALEY, PRESIDENT INTERNATIONAL ASTRONAUTICAL FEDERATION

Mr. HALEY. Mr. Chairman and members of the committee, my residence and curriculum vitae are contained in an attachment to this statement. I will not read the biographical material, but I would appreciate your kindness in including it in the record.

The CHAIRMAN. It will be included in the record.

Mr. HALEY. In addition thereto I would like to point out that shortly after World War II broke out I was inducted into the Service and was appointed Chief of the Military Affairs Division in the Office of the Air Judge Advocate. At the request of scientists associated with the California Institute of Technology, Gen. H. H. Arnold released me from the military service to become president of Aerojet Engineering Corp., which I had previously founded in Pasadena, Calif., for the purpose of making rocket motor and propulsive systems.

I served as president until after V–E Day. I point this out merely to indicate that I have worked with my hands in rocketry and that I am not solely a legal theoretician.

Incidentally, the great British rocket inventor, William Congreve, was also a lawyer.

To complete the record I also append to this statement a bibliography of my recent writings.

I just want to make the record perfectly clear what my past activities in the field were.

I listened yesterday to the testimony and examination of Prof. John Cobb Cooper and the Honorable Loftus Becker, legal adviser to the Department of State. I have no comment to make on the testimony of Professor Cooper other than to say that I thoroughly agree with his statements, except in some very minor respects which I will not dwell upon.

With respect to this latter statement I would like to state that in my day and generation, this is like a young lawyer 25 years old saying that he disagrees with Chief Justice Hughes or something of that nature. Because throughout the world there is no more revered or respected legal personality than Prof. John Cobb Cooper. And when I say I disagree with him on some minor matters, it is only with respect to administrative details.

Professor Cooper is world renowned and revered.

Fundamentally, I also do not disagree with most of what was said by Mr. Becker. I desire to impress upon the committee that I am commenting on Mr. Becker's testimony from memory, as I do not have a copy of his statement or a transcript of the testimony, and if I have misunderstood his statements I hope to have the opportunity to file corrections.

I had to give a lecture last night at New York University and I left the hearing room and dictated this on my way. And it was reproduced this morning. Therefore, I have had no further opportunity to look into the matter.

My impression is that the first half of Mr. Becker's statement is really inconsistent with the second half. I ask you to reread his statement in the light of this analysis. I think Congressman Hays sensed this problem when he commented on differences between civil and military legal disciplines

I also think Congressman Sisk sensed the problem. In the first half Mr. Becker commented critically on many viewpoints, most of which I have enunciated. However, I think his comments are based not on legal considerations, but rather on political considerations. With respect to political considerations I am wholly incompetent to make judgments, and Mr Becker is one of the most competent.

This is the crux of the matter This is apparent from the fact that Mr. Becker quotes article 51 of the United Nations Charter relating to the inherent right of nations to defend themselves against armed attack

In my writings I have wholly ignored political considerations and I have especially ignored that classical ultima ratio of international politics—namely, warfare War is the last resort, the ultimate decision, and I have ignored that stark decision as not being within the science of jurisprudence, but as being the final consideration of politics.

War is not my problem while I am considering jurisprudence.

If any nation in the world projects a military missile over the United States without our permission, whether it be at an altitude of 1,000 feet or 1,000 miles, I would hold that this is wholly outside the law and is an act of war. The viewpoints criticized by Mr. Becker, in my opinion, are wholly sound, in that they relate to peaceful and civilian legal concepts rather than to military and political concepts. In the second half of his paper Mr. Becker does dwell upon civilian and peaceful aspects of the problem of space jurisdiction and I think that

most of his conclusions are quite correct and are inconsistent with his earlier thinking. No lawyer could deny the right of the United States, or any other sovereign nation, to protect itself, and it is unthinkable that we would relinquish one iota of our sovereignty in this respect in outer space or anywhere else. But this committee or this witness is not considering at this time this vital inherent right. We are simply considering the normal establishment of jurisdictional boundaries, such as now exist, and also the establishment of civilian agencies, such as the NACA, ICAO, WMO, and so on.

I have good reason to believe, based upon a great deal of research effort made by many of the greatest theoretical physicists in the world, that it is quite unscientific to state that air as air extends 10,000 to 100,000 miles above the surface of the earth. I will discuss this point later.

Incidentally, with the permission of the chairman I would like to submit for the record a letter I just received from Dr. Eugene Sänger, one of the world's great experts in the field of upper atmosphere. This is one example. He is the famous Sänger who started the ICBM program for Germany, and he points out that he not only agrees with the viewpoints I am going to express here later, but he also says the Bonn Government of Western Germany, through Dr. Gerlach, the chief legal officer, also agrees with his viewpoints.

If I have your permission I will submit a copy of that letter to Mr. Feldman.

The CHAIRMAN Do you want to make it a part of your remarks?

Mr. HALEY. Yes.

The CHAIRMAN. Without objection, it will be made a part of your remarks in the record.

(The above-mentioned letter follows:)

FORSCHUNGSINSTITIT FÜR PHYSIK DER STRAHLANTRIEBE E. V. STUTTGART,
Stuttgart-Flughafen, April 9, 1958.

DR. ANDREW G. HALEY,
President of the International Astronautical Federation,
Washington, D. C.

DEAR ANDY: From the viewpoint of the engineer, the upper limitation of national sovereignty would seem rather suitable at an altitude between 40 and 55 miles, as follows from your, and Mr. von Kármán's suggestions.

Flying bodies relying solely on aerodynamic lift cannot rise above this limit, and it is only these bodies that can actually change their path at will, and thus are enabled to avoid obstacles, such as national boundaries, at will.

Above these altitudes, flying objects already follow predominantly paths of inertia which cannot anymore be governed at will. Thus, bodies, flying at such altitudes, cannot avoid national borders any more, try as they might. Jurisdictional lines extending beyond these altitudes therefore could render any flight impossible.

The engineer must thus demand the upper limitation of national sovereignty in that region, where, the predominantly aeronautical flight, due to decreasing density of air, changes into the predominantly ballistic flight. This is the case in the region between 40 and 55 miles' altitude, suggested by you and Mr. von Kármán.

As far as I know, Dr. Gerlach, principal officer for space travel in the Federal Department of Traffic at Bonn, has worked on these problems, and has apparently arrived at similar results.

Sincerely yours,

SÄNGER.

Mr. HALEY. As a private United States citizen I favor the international adoption of an agreement defining the jurisdiction of outer

space for the same reason as does Mr. Becker—namely, so that no other nation may prevent the United States from using outer space for peaceful purposes.

At the present time, as Professor Cooper has pointed out on several occasions, any nation could now stop such scientific research by simply protesting. Great Britain, the Dominican Republic, Haiti, and others, could stop our present operations at Cape Canaveral immediately. Before proceeding to a further detailed discussion I might add that the domestic, municipal statutes and laws of all the nations of the earth, in each case, provide that the sovereignty of each nation shall extend through airspace.

I have appended to this statement a compilation of the citations to these statutes.

I think this is the first in existence—the first such compilation.

I have been unable to find any statute in which sovereignty is extended above airspace. I repeat, airspace is airspace and air is air—air is not something else, such as hydrogen or oxygen atoms, nor is it the atmosphere of the sun, nor is air meteoritic dust. Under all rules of statutory construction we must consider air as air and airspace as airspace, not as something else. Dog is not wolf. Man is not ape. In high altitudes air may be extremely rarefied, and it is still air until atoms dissociate—but it is a substance which, no matter how rarefied, if condensed to sea level is still that which we breathe and which is viable.

We cannot leave the question of establishing the limits of sovereignty and the boundaries and jurisdiction in a perpetual vacuum, nor can we keep this question on a case-to-case basis. What is the jurisdiction of this Select Committee on Astronautics and Space Exploration?

Is it a meaningless thing? Is it nonsense?

What is the jurisdiction of the Senate Special Committee on Space and Astronautics? What is the jurisdiction of the Civil Aeronautics Board? What is the jurisdiction of the International Civil Aviation Organization (ICAO)? What will be the jurisdiction of the new agency which is intended to be created by Congress? What is the jurisdiction of the Advanced Research Projects Agency? How are we going to restrain 80 or 90 other countries from handling the problem of jurisdiction?

Never before in the history of mankind has the necessity arisen so quickly to state legal parameters in connection with a vast new area of social change. The legal problems presented by the advent of space flight have been climactic, and technology has far outstripped the formulation of the legal rules. The gap has widened to the point that the peace of the world may be threatened. I am grateful for this opportunity to express my views, and I am grateful to the Members of the House and Senate, and to the President and the Secretary of State for the expressions of their own awareness of the need for orderly solutions.

Indeed, I am grateful to be present at probably the most well-selected committee that this great institution, this great Congress, could afford a person to talk to.

In arriving at a level-headed statement of the jurisdiction of space law, the lawyer must turn for help to the physicist to ascertain just

where airspace ends. The sound scientist avoids legal interpretation, while at the same time making essential contributions by staying within his technical expertise, and keeping the lawyer well advised on appropriate physical phenomena. Such has been the most helpful role of Dr. Theodore von Karman.

Dr. von Karman has suggested practical methods of formulating the jurisdiction of airspace. By the same token the jurisdiction of outer space.

Last spring he delivered a paper at the University of California entitled "Aerodynamic Heating—the Temperature Barrier in Aeronautics." In that paper he had occasion to use a diagram made by Masson and Gazley of the Rand Corp. showing the possible ranges for continuous flight in the velocity-altitude coordinate systems.

Pursuant to von Karman's suggestion, I devised a diagram—figure 1—containing curves showing the high-altitude sounding rocket regime, the earth orbital satellite regime and the Kepler regime—earth escape velocity—and some supernumerary information, but most important is what we shall now call the Karman primary jurisdiction line.

To establish sound bases for demarcation of air and space jurisdiction, it is necessary to consider that the conditions for accomplishing aerial flight, that is, to circle at constant altitude, are weight equals aerodynamic lift plus centrifugal force. The aerodynamic lift decreases with altitude because of the decreasing density of the air and in order to maintain continued flight beyond zero air lift, centrifugal force must take over.

Consider the flight of Capt. Ivan C. Kincheloe, in which he took the X-2 rocket plane to 126,000 feet altitude. That is this cross-hatched area down in here. (Fig. 1.)

His flight was strictly an aeronautical adventure and did not partake of space flight. At the altitude indicated aerodynamic lift carries 98 percent of the weight and only 2 percent is centrifugal force, or "Kepler force."

It will be noted that in the corridor of continuous flight when an object reaches approximately 275,000 feet and is traveling at 25,000 feet per second, the Kepler force takes over and aerodynamic lift is gone. This is a critical jurisdictional boundary.

Figure 1 is intended to be illustrative. The Karman line may eventually actually remain as shown on figure 1—it certainly is staying there as far as my investigations are concerned—or, after due consideration, the line may be significantly changed. In any event, this is the line at which airspace terminates.

Any such definition should be finally promulgated through the United Nations or by multilateral treaty arrangements and implemented by the International Civil Aviation Organization (ICAO).

Along the same line you are now utilizing the NACA.

(Figure 1 follows:)

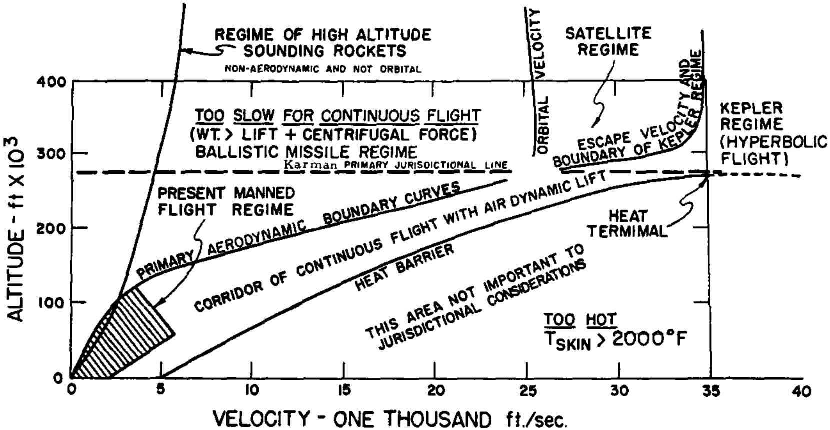

FIGURE 1

DIAGRAM SHOWING REGIMES OF ATMOSPHERIC AND EXTRA-ATMOSPHERIC FLIGHT AND DEPICTING THE JURISDICTIONAL BOUNDARY LINES

HALEY EXTRAPOLAT.

In determining the Karman line, the United Nations and ICAO will require the advice of a committee in stating the final definitions and in drafting detailed regulations. The basic statutes of ICAO will have to be broadened by international agreement and the name undoubtedly must be changed.

Just like you change the name of the agency in the NACA.

The first important action taken so far was the establishment in Barcelona by the International Astronautical Federation of the Cooper Committee, headed by world-renowned Professor John Cobb Cooper, and which will consist of three lawyers and four physicists who will define airspace and space jurisdiction.

I am advised by Professor Cooper that due to the inability of the committee to get together for other reasons that he may desire to resign as head of this committee.

He was unanimously appointed chairman of the committee because he was the best-qualified man in the world, the best lawyer, we thought, in the world to head the committee. And if for reasons now he cannot continue on as head, well that is something we can't help.

It would be senseless to build a surface trans-Atlantic steamship to perform the undersea functions of a submarine. The functions of the aircraft and the rocket ship are essentially even more disparate. In arriving at a reasonable Karman line, physicists and lawyers inevitably will reach agreement as to the point where the aeronautical vehicle no longer may perform efficiently and within reasonable physical and engineering parameters. It may be useful to examine, momentarily, some of these parameters.

A. M. Mayo has pointed out that control of the pilot's immediate environment from the standpoint of pressure and composition would become increasingly difficult as a function both of the length of time of flight and of the pressure reduction and change of atmospheric composition.

He goes on to state that at altitudes below approximately 70,000 feet the problem of pressurization and composition is taken care of relatively easily by pressurizing outside air. At higher altitudes, pressurization of outside air becomes increasingly difficult both from the standpoint of the power required and from that of handling the very high temperatures resulting from extreme ratios.

He also states that as outside pressures become negligible with respect to cockpit pressure, the problem of explosive decompression or even gradual loss of pressure becomes so acute that until pressurized cockpits are as highly reliable as the wings and basic structure of present aircraft, we will need to provide some sort of pressurization safety equipment.

Mayo states that information on the intensity and scope of cosmic radiation, together with data on their effect on human beings, is needed by the engineer Questions as to the possible existence of dangerous levels of radiation, such as X-rays from the sun, should also be surveyed. No completely practical approach to methods of protecting occupants of aircraft against high-energy radiations has yet been outlined. The problems might be reasonably simple were weight not such a primary consideration in all aircraft design problems.

Many other considerations will enter into the final determination of the Karman line, such as the danger of material collisions with the

airframe, escape problems, the problems posed by combined stresses and multifold fundamental questions of the construction of aircraft, as such, will all enter into the final decision.

H. Strughold points out that with increasing altitudes, some of the biological effects creep in gradually, while others rise at sharply defined levels. On the whole, the road from the surface of the earth to free space displays characteristic ecological stages. These stages are determined by the functions which the atmosphere has for man and craft.

He points out that we must first consider the oxygen component in the chemical constitution of the air. In this respect, only the lower half of the troposphere can be designated as the physiological atmosphere or the ecosphere of the air. It is in this narrow zone that the stage for the drama of life on our planet is normally set. Only this layer deserves the name "atmosphere" which, from the Greek word "atmos," means "breath."

E. O. Hulburt states that the region of the atmosphere from 0 to 6.2 miles, where the temperature falls rapidly with increase of altitude, has long been called the troposphere. The region from 33,000 to 66,000 feet, where the temperature is approximately constant, is called the stratosphere.

The ionosphere has its own well-accepted nomenclature, the terms D, E, F_1 and F_2 designating the four ionized regions with maxima of ionization at about 43.5, 62.1, 124.3, and 186.4 miles, respectively. Aside from these, there is no generally accepted terminology of upper atmospheric regions.

The terms "upper" and "outer" atmosphere are used with different meanings fairly elastic. The region from about 12.4 to 21.7 miles which embraces most of the ozone has been called the ozone layer or ozonosphere. It has been proposed that the region from the top of the stratosphere, at about 12.4 miles to the minimum of temperature, at about 43.5 miles be called the mesosphere and the region of increasing temperature, somewhere above 62.1 miles, the thermosphere.

The exosphere has been used to refer to the outer fringe of the atmosphere, where the air particles execute long elliptical orbits bouncing outward from impacts with other particles and falling back under gravity. In general, Hulburt concludes, the physical properties of the various regions are not yet well enough known to permit their fixation by an accepted terminology.

In their most recent writings, Cooper and Mayer have sought to locate airspace jurisdiction at a point in the ocean of air surrounding the earth where aerodynamic lift is gone. These authorities have avoided the mistakes of engineers and sociologists suddenly turned amateur lawyers who are attempting to locate airspace jurisdiction in such heterodox and altogether eclectic regions as the thermosphere, exosphere, mesosphere, and ozonosphere, even the nomenclature of which is doubtful, and none of which has any reference whatsoever to the problem at hand.

Under certain conditions national jurisdiction will be quite indirectly but effectively maintained over what is called by Professor Cooper "contiguous space." In the near future the nations of the earth will be offered point-to-point rocket communications involving many services.

The trajectories of each of these routes will be different, and will involve different altitudes. Some of these rockets will describe a trajectory requiring heights of 300 miles or less, and others will probably require heights in excess of 1,000 miles. National jurisdiction will be effectively maintained by the granting of launching and landing rights, and thus there will be indirect national control with respect to point-to-point earth rockets over contiguous space. With the advent of manned rocket ships, this control undoubtedly will become more severe because of vastly increased considerations of safety and other problems.

I hope you will listen to this because this goes right to the very fundamental of the goodness, the necessity, for the creation of your committee here. Your committee is essential.

The international regulation of point-to-point earth rocket vehicles will be under the jurisdiction of a successor international governmental organization to ICAO. The very problems of locating instrumentation along the manifold aerodynamic and nonaerodynamic routes, orbits and trajectories, will require the highest degree of international cooperation and regulation for the operational efficiency and safety of all concerned.

The aircraft, the point-to-point earth rocket ship, and the spaceship capable of freely maneuvering in outer space when navigating around earth or landing on earth, will each need navigation aids, anticollision devices, secondary radar, communications systems, meteorological services and many other international aids and services. In every instance of movement to or from any point on earth, the national licenses and permits which are the essential prerequisites of national society will be needed.

Mankind must mature appreciably to create an international authority having sole and complete jurisdiction over space flight and such an achievement must await the wise action of future generations.

We are simply not prepared for it today. That makes all the more important the domestic legislation that you enact and the domestic agencies that you set up.

No single nation has a paramount claim to outer space nor a monopoly on the scientific genius which will soon make its exploration and exploitation a reality.

The field of astronautics will progress only as international cooperation in the field is achieved.

National sovereignty ends for all purposes with the Karman line, and by adding by way of analogy the Stephen Decatur Doctrine demonstrated 150 years ago that:

The seas beyond reasonable coastal areas (space beyond the Karman line) are free and subject to control by no single despot or nation, and

The sponsors of ships at sea (spaceships in space) must be responsible for the conduct of their vessels.

More than 50 nations are participating in the IGY. This involves very extensive utilization of governmental and nongovernmental facilities and personnel. Active participation in the program is required of each nation, of its army, navy, air force, and coast guard personnel and facilities; of such governmental agencies as those concerned with standards, radar, radio, meteorology, weather, coast and geodetic surveys, geological surveys, and all types of official scientific and research organizations.

I point this out merely to indicate that I disagree here again with the testimony of Mr. Loftus Becker yesterday that the IGY was simply a little matter between a group of scientists who had no official capacities to do anything. I would like to point out that certainly the National Science Foundation is not unofficial—it receives its appropriations from Congress. I would like to point out, also that Mr. Eisenhower is still President of the United States. And he is the one who authorized the satellite program. And as far as the rest of the nations in the world are concerned, there is no question there, because in every other instance, the people who have authorized appropriations are those who are taking part in these enterprises and they are government employees and high officials of government.

Nevertheless if the United States Navy were not put to the burden of making the Vanguard from scratch and doing a great job of it as it was, I believe the job never would have been done. Some private scientists could not have built the Vanguard.

In addition, parallel, nonofficial institutions are involved, including universities and observatories in those few countries where such institutions are not owned and controlled by the state.

By agreeing to support actively the satellite program, the nations of the earth also agreed to the legal validity of the project.

Now this argument here is very attenuated. This is the substance of an article which was published by the Harvard Law Recorder. And it is annotated in the papers appended to my statement. Two or three say the argument is not valid. They have given no citations. I give hundreds of citations why the argument is valid.

I have heard many lawyers in and out of the Iron Curtain countries and Scandinavia and some of the great lawyers in Italy say the argument is valid. So, there you are

On the basis of sound principles of international law, the nations of the world may not protest the flight of nonmilitary artificial satellites over their territories when the purpose of such flight is the accumulation and dissemination of scientific data which shall be made available without restriction to all the nations of the world.

No single formal treaty emerged from the myriad agreements involved in the IGY. Nevertheless, a valid and binding world pact emerged from these acts of agreement and cooperation.

The international pact, in written form, may be abstracted from the thousands of documents and exchanges from which the living IGY has evolved There is nothing about a single formal treaty which makes it sacrosanct or makes it even an essential source of international law. In many instances the principles set forth in the treaty itself may have been established in international law long prior to the signing of the formal document itself. A rule of international law does not receive its validity from its enactment into a legal instrument such as an international law which is valid although not enacted in such legal instruments; and there are rules of international law which are not valid, although enacted in such instruments. Enactment, therefore, is no objective criterion for the alleged validity of a rule of international law.

The social scientists, just as clearly as the natural scientists—when I refer to social scientists, I mean a person who practices the science of jurisprudence—has the duty to acquire baseline data and then to implement such data in the dynamic evolution of society.

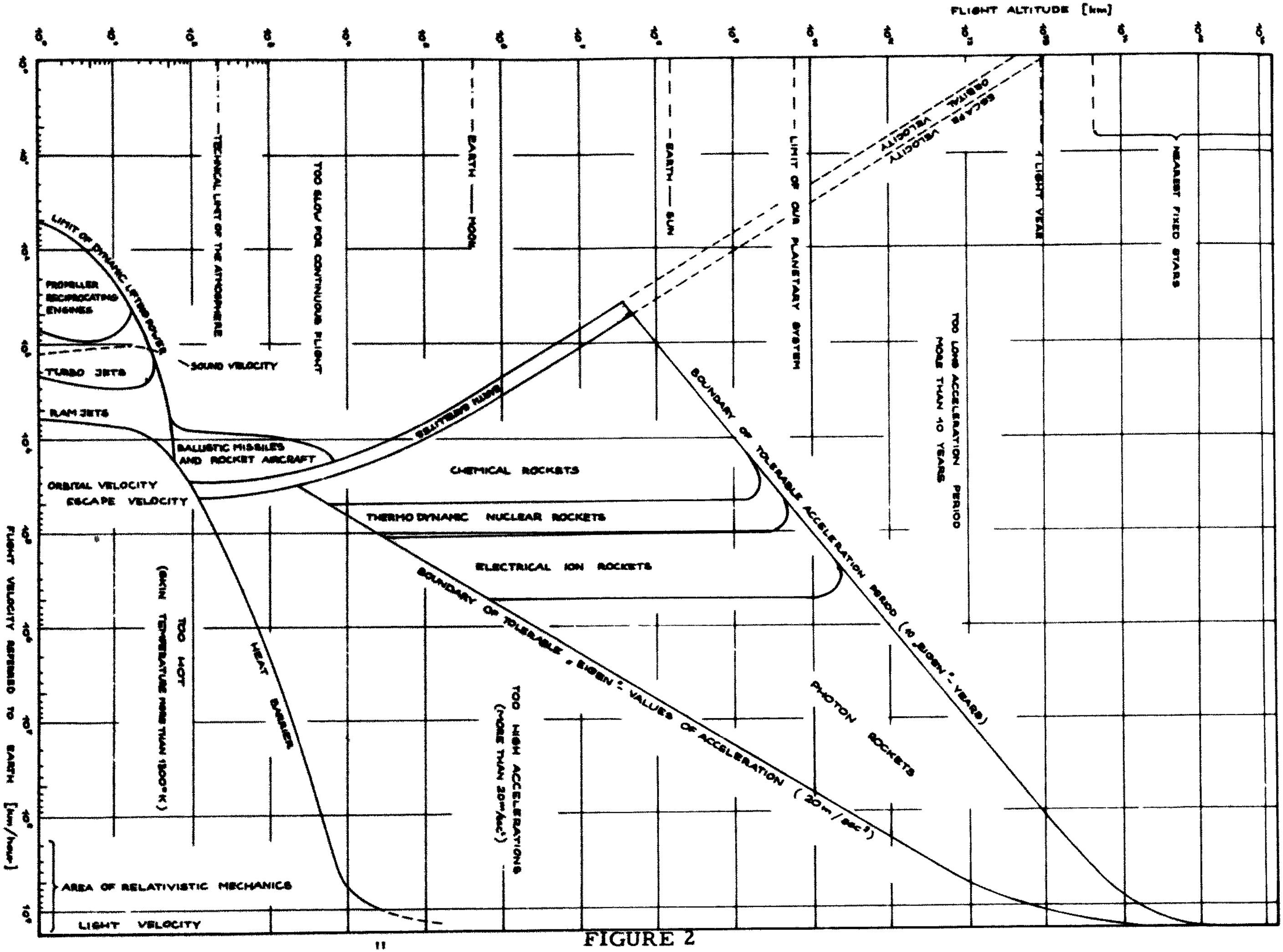

FIGURE 2

THE EUGEN SANGER SCHEMATIC DIAGRAM ILLUSTRATING ALL POSSIBLE TYPES OF FLIGHT REGIMES (ALTITUDE versus VELOCITY)

The advent of the rocket motor, with its potential of unlimited access on the earth and in space, presents a great new mutation requiring the immediate and careful attention of the social and natural scientists. The baseline material of the lawyer has always been invested in the mores of mankind from which it must extrapolate principles of justice.

As this is the Space Exploration Committee of the greatest legislative body in the history of humanity, I believe it is appropriate to point out that at this time we may postulate necessary rules of space exploration—namely, in any instance where there is reason to believe that intelligent life exists on a planet, no earth spaceship may land without having satisfactorily ascertained that (1) the landing and contact will injure neither the explorer nor the explored; and (2) the earth ship has been invited to land by the explored.

The regulation must be adhered to without exception, or we will project into space and perpetuate the bleak and devastating geocentric crimes of mankind. Further, we must conquer certain problems of semantics before we are worthy of space travel beyond our solar system.

This principle is just as old and simple as the basic idea of justice itself. It is a kind of compact not to harm or be harmed.

The Golden Rule has no application whatsoever in the field of metalaw. In metalaw we deal with all frames of existence—with intelligent beings different in kind. We must do unto others as they would have done unto them. To treat others as we would desire to be treated might well mean their destruction. We must treat them as they desire to be treated. This is the vastly significant premise of metalaw.

Metalaw was earlier defined as the law governing the rights of intelligent beings of different natures and existing in an indefinite number of different frameworks of natural law. An intelligent multidimensional creature would probably be so inferior as to require most considerate and sympathetic understanding and treatment by a three-dimensional universe, such as we conceive of mankind. The intelligent mankind concept runs into deep trouble vis a vis an intelligent two-dimensional creature existing in a three-dimensional continuum and problems of metalaw become truly complicated when one considers a man's relationship with intelligent two- and one-dimensional creatures existing in a two- or one-dimensional universe.

With the assistance of Dr. Eugene Sänger and Dr. Irene Sanger-Bredt the possible types of flight regimes, including those regimes which might philosophically spell the elimination of a dimension were illustrated by a diagram (fig. 2). Within this coordinate system, the domains of aeronautics, the transition domain from aeronautics to astronautics and the domain of astronautics are plotted.

(Fig. 2 faces this page.)

Mr. HALEY. Within this coordinate system, the domains of aeronautics, the transition domain from aeronautics to astronautics and the domain of astronautics are plotted.

Proper aeronautics, characterized by air-breathing propulsion systems, reaches up to about 50 miles. It lies between the two well-known limiting curves—namely, the limit of aerodynamics lifting power and the heat barrier. This domain plot shows an onion-peel shape (attaching one onion-peel to the next by increasing flight

velocities and altitudes) when progressing from propeller reciprocating engines to turbojets and then to ramjets.

Though aerodynamic lifting power is gradually replaced by the centrifugal force from the trajectory curvature beyond a velocity of 62,000 miles per hour, the intersection of the curves of limit of aerodynamic lifting power and heat barrier is nevertheless physically real and constitutes as the utmost limit of the ramjet also the definite limit of aeronautics.

Contrary to this, ballistic rockets and rocket aircraft are not limited by the limit of aerodynamic lifting power due to their "nonair-breathing" propulsion systems and they can fully exploit the lifting support of the inertial forces due to the trajectory curvature from about 3,730 miles per hour on, so that their possible altitudes of flight increase to several thousand miles and their flight velocities approach orbital velocity. The aerodynamic lifting power then is completely replaced by the inertial forces of the circular orbit about the earth.

These ballistic missiles and rocket aircraft form the transition domain from aeronautics to astronautics which flow into the domain of pure astronautics with the reaching of the orbital velocity. Hence, only a very small corridor connects aeronautics with astronautics.

Within the narrow band between orbital velocity and the constant—2-times larger escape velocity lie the artificial satellites on the earth.

This band curves to decreasing flight velocities with increasing altitude due to the decrease of the gravitational acceleration by the square of the altitude over the earth.

Beyond this band there open the immense vistas of interplanetary, interstellar and intergalactic space flight, in a structural shape surprisingly similar to that of aeronautics according to present concepts.

Thank you.

(Curriculum Vitae; Contributions on Space Law, etc.; International Astronautical Federation Bulletin, follow:)

CURRICULUM VITAE

Andrew G. Haley (1735 De Sales Street NW., Washington, D. C.) president of the International Astronautical Federation and general counsel of the American Rocket Society, was born in Tacoma, Wash. (November 19, 1904), and was educated at George Washington University (A. B. degree) and Georgetown University (LL. B. degree). A lawyer by profession, he has devoted a major part of his lifetime to "working with his hands in rocketry" and to practicing law in the technical fields, namely, radio, television, hydroelectric power, and in all branches of rocket propulsion. Prior to World War II he was counsel for the Federal Communications Commission. He was cofounder, president, and managing director of Aerojet Engineering Corp. (now the world's largest rocket company) during the period of World War II He was lecturer, First Jet Propulsion School, organized under military orders (1943). After he resigned as president of Aerojet, he served for a year as adviser on aircraft to the United States Senate Special Committee Investigating the National Defense Program and wrote a report for that committee urging Congress to stepup support of rocket research and development.

He served as legal adviser to the 87-nation International Telecommunication Conference at Atlantic City in 1947, and to the Fourth Inter-American Radio Conference in Washington, D. C., in 1949 He served as industry adviser to the Third North American Regional Broadcasting Conference at Montreal in 1949 and in Habana and Washington, D. C., in 1950; the Mexican-United States Broadcasting Conference in Mexico City in 1954 and in Washington, D. C., in 1955. He attended as observer the NATO Guided Missile Symposium in Munich,

April 23–27, 1956; the Sixth General Assembly of the Advisory Group for Aeronautical Research and Development (AGARD) to NATO, in Brussels, August 29–31, 1956; the Eighth Plenary Assembly of the International Radio Consultative Committee (CCIR) of the International Telecommunication Union (ITU) in Warsaw, August 31–September 5, 1956; the Ninth International Congress of Applied Mechanics at the Free University of Brussels, September 5–9, 1956; the Comite Special de l'Annee Geophysique Internationale (CSAGI) in Barcelona, September 9–12, 1956; the Guided Missile Seminar Guided Missile Committee of the Aircraft Industries Association (AIR) in Venice, September 24–27, 1956; and the Ninth Session of the UNESCO General Conference in New Delhi, November 9–18, 1956. He participated (as a member of the Human Factors Panel) in the Astronautics Symposium held in San Diego, Calif., February 18–20, 1957, under the sponsorship of the United States Air Force Office of Scientific Research and Convair Division of General Dynamics Corp. He organized and attended meetings of the members of the International Affairs Committee of the International Astronautical Federation and their consultants with officials of UNESCO in Paris, France, April 15–16, 1957.

In 1951 he was an American Rocket Society delegate to the Second International Astronautical Congress in London and was elected vice president of the International Astronautical Federation (IAF), to which office he was reelected at the Third Congress of the IAF held in Stuttgart in 1952 and at the Fourth Congress of the IAF held in Zurich in 1953. As vice president of the IAF he attended the Fifth Congress held in Innsbruck in 1954, and he attended the Sixth Congress of the IAF held in Copenhagen in 1955 as chairman of the delegation from the American Rocket Society. He was chairman of the International Affairs Committee and a member of the Finance Committee of the IAF until taking office as president. He was chairman of the delegation from the American Rocket Society to the Seventh International Astronautical Congress (IAF) held in Rome in September 1956, and to the Eighth International Astronautical Congress held in Barcelona October 7–12, 1957.

Mr. Haley was vice president of the American Rocket Society in 1953 and president in 1954. He served as a director of the American Rocket Society, 1951–52, and was reelected a director for the period 1955–57. He was the first chairman of the ARS Committee on Space Flight in 1952 and served again as chairman in 1953. As president of the ARS in 1954, he submitted a proposal to the National Science Foundation to sponsor a study of "The Utility of An Artificial Unmanned Earth Satellite," prepared by the Space Flight Committee. In January 1956, he was elected chairman of the board of directors of the American Rocket Society, a post to which no other director has been elected.

The membership of the American Rocket Society on December 2, 1954, presented Mr. Haley with a special award in the form of an engraved plaque "in appreciation for distinguished service and untiring efforts on behalf of the society during his term as president."

In 1953 he established by endowment the American Rocket Society Astronautics Award. The recipient in 1954 was Dr. Theodore von Karman; in 1955, Dr. Wernher von Braun; and in 1956, Dr. Joseph Kaplan.

He is a member of the Institute of Aeronautical Sciences, Society of Motion Picture and Television Engineers, Radio and Television Executives Society, Inc., Radio Pioneers, American Rocket Society, American Society of International Law, American Astronautical Society, American Television Society, American Bar Association, District of Columbia Bar Association, Federal Communications Bar Association, Federal Bar Association, Bar Association of Tennessee (honorary) Delta Theta Phi legal fraternity, Associatione Italiana Razzi, Dansk Interplanetarisk Selskab, Deutsche Gesellschaft fur Raketentechnik und Raumfahrt, Deutsche Arbeitegemeinschaft fur Raketentechnik, Japan Astronautical Society, Nederlandse Vereniging voor Ruimtevaart, Norsk Astronautisk Forening, Oesterreichische Gesellschaft fur Weltraumforschung, Svenska Interplanetariska Sallskapet, Sociedade Interplanetaria Brasileira, Société Francaise d'Astronautique, Fellow of the British Interplanetary Society, South African Interplanetary Society and of the Sociedad Argentina Interplanetaria; and honorary member of Schweizerische Astronautische Arbeitsgemeinschaft. Mr. Haley is vice chairman of the newly created Committee on Space Law of the American Bar Association.

He is the author of numerous articles published in Jet Propulsion, Harvard University Law Record, Tennessee Law Review, Journal of Air Law and Com-

merce of Northwestern University, Technical University of Stuttgart, Institute of Air Law at the University of Cologne, and of numerous other learned organizations. A book, Law of the Space Age, is about to be published by Public Affairs Press, Washington, D. C.

Who's Who in America, 1956–57, p 1061
Martindale-Hubbell Law Directory, 1957, p 780
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CONTRIBUTIONS BY ANDREW G. HALEY ON SPACE LAW AND METALAW AND INTERNATIONAL RELATIONS

"International Cooperation in Rocketry and Astronautics" Jet Propulsion, the Journal of the American Rocket Society, New York, N. Y., Volume 25, Issue No. 11, November 1955

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"The Present Day Developments in Space Law and the Beginnings of Metalaw." Presented at the American Rocket Society 11th Annual Meeting, New York, N. Y., November 26–29, 1956, Harvard University Law Record, Volume 24, Issue No. 2, February 7, 1957

"The Present Day Developments in Space Law" The Canadian Oil Journal, Edmonton, Alberta, Canada, Volume 8, No 7, March 1957, Volume 8, No. 8, April 1957; Volume 8, No. 9, May 1957

"Seventh IAF Congress Stresses Cooperation" Jet Propulsion, the Journal of the American Rocket Society, New York, N. Y., Volume 27, Issue No. 1, January 1957.

"Space Law and Metalaw—Jurisdiction Defined" Presented at the American Rocket Society Spring Meeting, Washington, D. C., April 3–6, 1957. Journal of Air Law and Commerce, of Northwestern University, Evanston, Ill., Vol. 24, Issue No. 3, summer 1957.

"The International Situation and Legal Involvements With Respect to Long-Range Missiles and Earth-Circling Objects," February 1957. U S Air Force Office of Scientific Research, Tempo T Building, Washington, D. C., Pergamon Press, Ltd., London, England.

"Weltraumrecht und Recht Ausserhalb der Erde." Zeitschrift fur Luftrecht, Instituts fur Luftrecht der Universitat Koln, Germany, Issue 2, 1957; Carl Heymanns Verlag KG, Koln, Germany

"Loi de l'Espace et Metaloi" Le Courrier Interplanetaire, Lausanne, Switzerland. Issues of February 1957; March 5, 1957, and April 10, 1957.

"Space Law and Metalaw—Jurisdiction Defined" (Revised). Paper read before the Deutsche Gesellschaft fur Raketentechnik und Raumfahrt, at the Technical University of Stuttgart, April 13, 1957

"Droit de l'Espace et 'Metadroit' (Limites de Jurisdiction)." Revue Generale de L'air, 1957, Paris

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"The International Scene" (German activity in Rocketry) Astronautics, Vol. 2, No 3, October 1957.

"Law Must Precede Man Into Space." Missiles and Rockets, Vol. 2, No. 11, November 1957.
"The International Scene, Suite 304, the Ritz, Barcelona," Astronautics, Vol. 2, No. 5, December 1957.
"The International Astronautical Federation." The Federal Bar Journal, October-December 1957, pages 470–474.
"Can Russia Claim the Moon?" The American Weekly, January 15, 1958.
"Space Law—Basic Concepts." Law Review Digest, Vol. 7, No. 3, March-April 1957. Digest of article published in the Tennessee Law Review, fall, 1956; Vol. 24, No. 5, pages 643–657.
"International Cooperation in Astronautics." Foreign Service Journal, April 1958, pages 42–50.
Others: "The Commercial Implications of Missiles, Satellites, Space Age." Address before the American Management Association, New York, N. Y., February 21, 1958; the Commercial and Financial Chronicle, March 13, 1958

[Reprinted from the Federal Bar Journal October-December 1957]

The International Astronautical Federation

Andrew G. Haley, President, International Astronautical Federation

The International Astronautical Federation was founded in Paris, France, during the autumn of 1950. The annual congress of the IAF have taken place successively at Paris (1950), London (1951), Stuttgart (1952), Zurich (1953), Innsbruck (1954), Copenhagen (1955), Rome (1956), and Barcelona (1957).
The Federation is now composed of the following Societies:

Agrupacion Astronautica Espanola
American Rocket Society.
American Astronautical Society
Asociacion Argentina Interplanetaria.
Association Egyptienne Astronautique.
Associazione Italiana Razzi.
Astronauticko Drustvo (Jugoslavia).
British Interplanetary Society
Commission on Astronautics, USSR Academy of Sciences.
Dansk Interplanetarisk Selskab.
Deutsche Arbeitsgemeinschaft fur Rakententechink.
Deutsches Raketen und Raumfahrt Museum e. V.
Deutsche Gesellschaft fur Rakententechnik und Raumfahrt.
Japanese Astronautical Society.
Nederlandse Vereniging voor Ruimtevaart.
Norsk Astronautisk Forening.
Oesterreichische Gesellschaft fur Weltraumforschung.
Polski Towarzystwo Astronauticzne.
Schweizerische Astronautische Arbeitsgemeinschaft.
Sociedade Interplanetaria Brasileira.
Sociedad Interplanetaria Chilena.
Societe Francaise d'Astronautique.
South African Interplanetary Society.
Svensk Interplanetarisk Selskap.
University of Cuyo (Institution Member).

The Eighth International Astronautical Federation Congress may be characterized as having placed emphasis on the organizational and business aspects of the Federation Mr Joseph A. Stemmer, secretary of the Federation, immediately raised questions concerning the legality and propriety of actions taken during the preceding Congresses—a matter which is of real and legitimate concern to Mr. Stemmer because of his duty to conform the actions of the Federation to appropriate Swiss law.
The British delegation, under the leadership of Dr L. R. Shepherd, Mr. L. J. Carter, and the new chairman of the British Interplanetary Society, Mr. K. W. Gatland, formally moved for the creation of a committee to thoroughly correct and revise the constitution of the Federation. The basic British proposal was enlarged somewhat by the action of the delegates in adding thereto an opportunity for the consideration by the committee of entirely new additions to the constitution.

The resolution finally adopted provided that "There is hereby created an ad hoc committee consisting of six members who will be nominated and elected by the member societies, and one of whom shall be designated as chairman by the president, which will be known as the Committee on the Correction and Revision of the Constitution Each member society shall submit to the president on or before January 31, 1958, his recommendations for the correction and revision of the constitution. Each such recommendation shall be considered and finally disposed of by the committee, and brief reasons shall be given for every such action. The committee may take final actions by majority votes of a quorum of the membership thereof, and a quorum shall consist of three members of the committee. The president shall be an ex officio member of the committee and his presence at a meeting shall be counted in reaching a quorum. The committee shall meet in persona within 150 days from January 31, 1958, and it shall submit to the president before the next congress a corrected and revised constitution with brief statements of reasons for each such correction and revision. The president shall submit said report to qualified Swiss legal counsel for his opinion as to the legality of the corrected and revised constitution, and all pertinent documents will thereupon be duplicated and submitted to the member societies for further consideration "

The committee appointed by President Shepherd consists of A. G. Haley, chairman, USA, Fritz Gerlach, Germany; Alla Massevitch, U. S S. R; Georges Delval, France; L J Carter, England; and J. A Stemran, Switzerland.

In view of the legal complications and involvements which are bound to arise as the result of ventures into space above the earth's atmosphere, I suggested the creation of a committee "to define the regions of jurisdiction of air law, and of space law." By common consent Prof. John Cobb Cooper, general counsel of the International Air Transport Association and world-renowned international lawyer, was named as chairman of the committee, which has been designated as "the Cooper committee." The committee will submit its findings and recommendations to the Secretary-General of the United Nations. A slightly more detailed description of the committee is contained in my paper which was presented at the Barcelona Conference "I urge that at a plenary session of this congress, the president of the International Astronautical Federation be authorized to appoint a committee of 7 persons, consisting of 4 physicists and 3 lawyers, who will draft a definition of airspace and recommend a rule delimiting airspace jurisdiction, such definition and rule to be supported by a statement of findings of fact and conclusions of law. The resolution should be transmitted to the attention of the Secretary-General of the United Nations and to the Secretary-General of the International Civil Aviation Organization (ICAO), with the statement that the committee will cooperate with the appropriate officials of said organizations."

The president, Dr. Leslie R. Shepherd, decided that no person other than Prof. John Cobb Cooper should be appointed to this committee with the exception that the name of Dr. A F. Spilhaus, dean of the Institute of Technology, University of Minnesota, was generally agreed to, and it was also agreed that Dr Sedov would arrange for the appointment of two Soviet scientists to the committee. It was also felt that the USA should be limited to two members, the U. S S. R. to two members, and that the rest should be named from such countries as Great Britain, Germany, France, Italy, from South America, and so on. It was the general consensus of the Congress that the Cooper committee, in addition to defining air jurisdiction and space jurisdiction as an adjective task, should also undertake the substantive task of stating jurisdictional rules.

The assembled delegates were pleased to hear from Dr. W. Schwabl of Springer-Verlag, the publisher of Astronautica Acta, that his company would print the papers delivered at the Barcelona Congress. By unanimous agreement Dr. Friedrich Hecht was named again as chairman of the Astronautica Acta Committee, which is also the committee which finally passes upon papers to be delivered at the Congresses, and he was authorized by President L. R. Shepherd to name the other members of this committee. In addition to himself as chairman, Dr. Hecht appointed Dr. Wolfgang B. Klemperer as vice chairman, and Dr. Shepherd, Dr. Sänger, and Dr. Sedov. Any paper to be delivered at the Ninth Congress in Holland must be approved in writing by one of these committee members. This in no way interferes with the authority of any member society to screen the papers initially in its own right.

I was elected president for the ensuing year, along with the following vice presidents: Mr. A. Hjertstrand, Sweden; Dr. J. M. J. Kooy, Holland; Prof. Leonid I. Sedov, U. S. S. R.; Dr. L. R. Shepherd, Great Britain; Prof. T. M. Tabanera, Argentina; and Prof. K. Zarankiewicz, Poland.

No final proposal is on hand for the 10th International Astronautical Federation Congress. Dr. Sedov has tentatively suggested Moscow as the host city, but he must ascertain whether arrangements can be made and he will report the official Soviet action within 2 or 3 months. If Moscow is unavailable, the 10th Congress will be held in London. In 1960, the 11th Congress will be held in Stockholm. This is a firm commitment. It was suggested that in 1961 the 12th Congress be held in Washington, D. C. The ARS delegation made it clear, however, that approval of the board of directors of the American Rocket Society must be obtained before any final action may be taken.

This is the first time a representative of the social sciences has been elected president of the Federation. I was impressed with the general feeling among the delegates that they desired to utilize my organizational experience derived from 30 years' practice of the law, and they also were impressed by the fact that the legal problems presented by the advent of space flight have been climaceteric, and space technology has far outstripped the formulation of legal rules, and the gap has widened to the point that the peace of the world is threatened. I was deeply encouraged and moved to accept the presidency because of the level-headed action of the delegates in authorizing the creation of the Cooper committee.

I intend to make every effort to broaden the influence of Astronautica Acta, to increase its circulation, and to suggest to the Astronautica Acta Committee that the board of editors and the advisory board be maintained on a current working basis.

I also would desire to increase the "worthwhileness" of the annual congresses. I intend to suggest that for 4 days of the congress two nonconflicting sessions run concurrently during the morning and afternoons. So that each and every person attending the congress will be satisfied that the time was well spent, I am suggesting that I be authorized, on the basis of recommendations from the committee, to invite a guest speaker to be the head of, or keynoter, of each of the sessions. Such guest speaker would have practically unlimited time to deliver his original paper and the assembled scientists would have adequate time for questioning and comment. This would leave, out of each session, 2 hours for the presentation of additional papers, the only inhibition on the additional papers would be that each such paper must be approved in writing by one member of the committee.

There is also what is known as the Sanger-von Karman-Haley proposal to create in the Federation an academy of astronautics. Persons would be elected to the academy for life tenure, and there would be a rotating directorate chosen from the members of the academy. Only scientists of real accomplishment in the natural and social sciences would become members of this academy. The administrative and executive activities of the Federation would be discharged by the council, as at the present time, but all actions taken by the officers would be subject to the general supervision and control of the academy.

Citations to Civil Aviation Laws

1. AFGHANISTAN

A. Statute: Civil Aviation Act of 1956 (text published Kabul, 1956).

B. Treaty: Convention on International Civil Aviation Chicago, December 7, 1944 (U. S. treaties and other international acts 1591, 1947).

2. ALBANIA

A. Statute: No specific statute. Exercise of sovereignty over airspace implied from numerous notes of protest against unauthorized flights over Albanian territory.

B. Treaty: Not a signatory of any convention or treaty concerning international civil aviation.

3. ARAB FEDERATION (JORDAN AND IRAQ)

Jordan

A. Statute: None.

B. Treaty: Bilateral agreement between Jordan and Turkey on Air Transport Services, May 20, 1948.

Iraq

A. Statute: Air Navigation Law No. 41 of August 6, 1939 (Waqayi al Iraqiya No. 1725 of August 16, 1939)

B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts 1591, 1947).

4 ARGENTINA

A. Statute: Law No. 14.307 of July 15, 1954 (Air Code).

B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S treaties and other international acts, 1591, 1947).

5. AUSTRALIA

A Statute: Air Navigation Act 1920 as amended through 1950 (acts of the Parliament of the Commonwealth of Australia, vol. 1, pp. 157–158).

B Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947)

6 BELGIUM

A. Statute: No specific statutory enactment.

B. Treaty: (1) Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919 (11 League of Nations Treaty Series 173). Ratified August 16, 1922 (Moniteur Belge, November 16, 1922). (2) Convention on International Civil Aviation, Chicago, December 7, 1944 (U S. treaties and other international acts 1591, 1947). Ratified April 30, 1947 (Moniteur Belge, December 2, 1948).

7. BOLIVIA

A. Statute: Supreme Decree of October 24, 1930

B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S treaties and other international acts, 1591, 1947).

8 BRAZIL

A. Statute: Decree Law No. 483 of June 8, 1938 (Brazilian Air Code).

B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

9. BULGARIA

A Statute: Edict on Territorial and Inland Waters of October 23, 1952 (IPNS No 85, as amended, November 9, 1951, IPNS No. 90)

B Treaty: Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919, (11 League of Nations Treaty Series 173). Convention for the Uniformalization of Certain Rules Regarding Air Transportation, Warsaw, October 12, 1929. Adherence by Bulgaria on September 23, 1949 (Todor Gabravski, Vuzdushnoto pravo na NR Bulgaria (The Air Law of the People's Republic of Bulgaria) Sotsialisticheskо Pravo (Sofia) 1956, No. 5, p. 49).

10. BURMA

A. Statute: The Burma Aircraft Act (Burma Code, 1944, vol. 2, pp. 526 ff.).

B Treaty Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

11. CANADA

A. Statute: The Aeronautics Act of Canada (Revised Statutes of Canada, 1952, vol 1, ch. 2).

B. Treaty. Convention on International Civil Aviation, Chicago, December 7, 1944 (U S. treaties and other international acts, 1591, 1947).

12. CEYLON

A. Statute: The Air Navigation Act, No. 15 of 1950 (Acts of Ceylon, 1950).

B Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U S. treaties and other international acts, 1591, 1947).

13. CHILE

A. Statute: Decree With Force of Law on Air Navigation (Diario Oficial of May 30, 1931).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1957).

14. COLOMBIA

A. Statute: Decree No. 66 of January 12, 1934.
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

15. COSTA RICA

A. Statute: (1) Constitution, November 8, 1949. (2) General law on civil aviation, October 18, 1949.

16. CUBA

A. Statute: Decree No. 548 of April 21, 1928
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

17. CZECHOSLOVAKIA

A. Statute: Law on Civil Aviation, September 24, 1956 (Law No. 47, 1956 Coll.).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

18. DENMARK

A. Statute: Danish Aviation Act of May 1, 1923 (Lav No. 175 om Luftfart, Danmarks Love (Laws of Denmark) 1665–1949, Kobenhavn, 1950, pp 1565–1573)
B. Treaty: Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919 (11 League of Nations Treaty Series 173). International Convention on Civil Aviation of 1944, Chicago, December 7, 1944 (U. S. treaties and other international acts 1591, 1947); ratified March 30, 1948 (Lovtidende C, 1948, text No. 17).

19. DOMINICAN REPUBLIC

A. Statute: Law on Civil Aeronautics (Law No. 1915 of January 19, 1949).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947)

20. ECUADOR

A. Statute: (1) Constitution, December 31, 1946. (2) Law on Air Transit of September 12, 1936.
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

21. EGYPT

(See United Arab Republic.)

22 ETHIOPIA

A. Statute: None.
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

23. FINLAND

A. Statute: Aviation Act (Ilmailulaki) of May 25, 1923, as amended (Suomen Laki (Finnish Law) Vol I, Helsinki, 1955, pp 416–417).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); ratified April 22, 1949 (Suomen Asetuskokoelma, 1949, item No. 331 and Suomen Asetuskokoelma Sopimussarja, 1949, item No 11)

24. FRANCE

A. Statute: Article 552 of the Civil Code.
B. Treaty: Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919 (11 League of Nations Treaty Series 173). Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

25. GERMANY, FEDERAL REPUBLIC OF

A Statute: Law Concerning Air Traffic, Law of August 21, 1936, as amended (Reichsgesetzblatt 1936, Part I, p. 653).

26. GREECE

A. Statute: None.
B. Treaty: (1) Convention for the Uniformalization of Certain Rules Regarding Air Transportation, Warsaw, October 12, 1929; ratified May 29, 1937 (Law No. 596). (2) Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

27. GUATEMALA

A. Statute: Constitution of February 6, 1956.
B Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

28. HONDURAS

A. Statute: Law on Aeronautics (Decree No. 121 of March 14, 1950).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

29. ICELAND

A. Statute: Islandic Aviation Law (Log um loftferdir) (Stjornartidindi, 1947, Part A, p. 81, No. 32).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); ratified April 2, 1947 (Stjornartidindi, 1947, Part A, p. 150, No. 45).

30. INDIA

A. Statute: Indian Aircraft Act, 1934, Section 17.
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1957).

31. IRAN

A. Statute: Decree of the Council of Ministers of August 5, 1938, on Air Navigation (R. Aghababian, Législation Iranienne Actuelle intéressant les étrangers et les Iraniens à l'étranger, Teheran, 1939, pp. 145–148).
Law of Civil Aviation July 19, 1948 (Law of Civil Aviation, Department of Civil Aviation, 1949).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S treaties and other international acts, 1591, 1947).

32. IRAQ

(See Arab Federation.)

33. IRELAND

A. Statute: Air Navigation and Transport Act, 1946 (§ 11, Acts of the Oireachtas, 1946).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

34. ISRAEL

A. Statute: Air Navigation Act of 1920 (10 & 11 Geo. 5, C. 80, Laws of Palestine, 1933, Vol. 3, p. 2401) continued in effect by Air Navigation (Amendment) Act, 5710–1950 (Laws of Israel, Vol. 4).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

35. ITALY

A. Statute: Law of August 20, 1923 (Regio Decreto Legge 20 Agosto 1923 No. 2207, Official Gazette of the Kingdom of Italy No. 233, 1923, as amended by Law of January 31, 1926, No. 1063, ibid. No. 111, 1926).
B. Treaty: Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919 (11 League of Nations Treaty Series 173); ratified 1922 (Official Gazette of the Kingdom of Italy No. 107, 1923).
Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); ratified 1948 (Official Gazette of the Republic of Italy No. 131, 1948).

36. JAPAN

A. Statute: (1) Article 207 Japanese Civil Code. (2) Civil Aeronautic Law (No. 231) of July 15, 1952, as amended by Laws No. 8278 of 1952, Nos. 66 and 151 of 1953, and No. 60 of 1954).
B. Treaty: Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919, (11 League of Nations Treaty Series 173). Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

37. JORDAN

(See Arab Federation.)

38. LEBANON

A. Statute: Lebanon Civil Aviation Law of January 11, 1949 (Official Gazette of the Republic of Lebanon, No. 3, Year 98, of January 19, 1949).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

39. SIBERIA

A. Statute: None, however, there is a statute regulating use of airports by foreign planes (Liberian Code of Laws of 1956, Vol. III).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

40. LIBYA

A. Statute: None, prewar Italian regulations still in force.
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

41. LUXEMBOURG

A. Statute: Law of January 31, 1948 (Memorial du Grand-Duche de Luxembourg of February 14, 1948, p. 203).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); adherence Law of March 25, 1948 (Memorial du Grand-Duche de Luxembourg No. 24 of April 14, 1948, p. 537).

42. MEXICO

A. Statute: Law on Means of Communication (Diario Oficial of February 19, 1940, Book IV as amended to December 30, 1950).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

43. NEW ZEALAND

A. Statute: Article 33 of Civil Aviation Act of 1948.
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

44. NICARAGUA

A. Statute: (1) Constitution, November 1, 1950. (2) Civil Aviation Code (Decree No. 176 of September 19, 1956).
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

45 NORWAY

A. Statute: Rules for the Entry of Foreign Warships and Military Aircraft into Norwegian Territory During Peace Time (Norok Lavtidend, No. 32, p. 1168).
B. Treaty: Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919 (11 League of Nations Treaty Series 173); ratified April 24, 1931 (Norwegian Treaty Collection, 1932, No. 1, p. 1) Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); ratified May 2, 1947 ibid., 1948, No. 3, p. 367).

46 PAKISTAN

A. Statute: Same as Aircraft Act of 1934 in force in India.
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

47. PANAMA

A. Statute: Decree No 89 (Civil Code of 1916, as amended)

48. PERU

A Statute: Regulation of Commercial and Civil Aviation (Supreme Decree of December 18, 1933).
B Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

49. PHILIPPINES

A. Statute: None.
B. Treaty: (1) Convention for Unification of Certain Rules Relating to International Transportation by Air, 1929 (Proclamation 201 of September 23, 1955). (2) Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S treaties and other international acts, 1591, 1947), ratified in the Senate on May 5, 1952

50. POLAND

A. Statute: Order of the President of the Republic of Poland of March 14, 1948 on the Aviation Law (Dz. U. of 1935, No. 69, Law No. 437).
B. Treaty: Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919 (11 League of Nations Treaty Series 173), renounced on April 5, 1948 (Dz. U. No. 21, Law No. 151). Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S treaties and other international acts, 1591, 1947).

51. PORTUGAL

A. Statute: Constitution of August 1, 1935.

52 ROMANIA

A. Statute: Air Code (Decree No. 516 of December 5, 1953, Bulentinul Oficial No. 56 of December 30, 1953).

53. SALVADOR

A. Statute: Constitution, September 8, 1950.

54. SAUDI ARABIA

A. Statute: None.
B. Treaty: None.

56. SOUTH AFRICA, UNION OF

A. Statute: Aviation Act, No. 16 of 1923 as amended by Act No. 41 of 1946 and No. 42 of 1947 (Union Statutes 1910–1947)
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947)

56. SPAIN

A. Statute· Law on the Bases of Air Navigation of December 12, 1947.

57. SWEDEN

A. Statute· Royal Ordinance on Aviation of May 26, 1922 (Sveriges Rikes Lag, 1957 ed., pp. B. 359–364)
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

58 SYRIA

(See United Arab Republic)

59 TURKEY

A. Statute: Regulation of Air Navigation of September 9, 1925
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); became integral part of Turkish National Law by Law 4749 of June 12, 1945.

60. UNION OF SOVIET SOCIALIST REPUBLICS

A. Statute: Air Code of September 3/13, 1935 (USSR Laws 1935, No. 34 Text 359 (a)).

61 UNITED ARAB REPUBLIC (EGYPT AND SYRIA)

Egypt

A. Statute: Section 1, of the Decret-Loi No 57 on Air Navigation of May 23 1935 (Journal Officiel 47)
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S treaties and other international acts, 1591, 1947), ratified by Law of March 2, 1947 (Journal Officiel 48 and 49)

Syria

A. Statute. Law Regulating Air Transportation and Navigation of November 28, 1948 repealed and replaced by Law Regulating Air Transportation and Navigation, 1949 (Journal Officiel No 66 of December 12, 1949).
B. Treaty Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

62 UNITED KINGDOM

A. Statute· Civil Aviation Act, 1949 (12 and 13 Geo 6, c. 67)
B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); ratified April 4, 1947.

63. UNITED STATES

A. Statute· (1) Air Commerce Act of 1926 (49 USCA 176). (2) Canal Zone Air Navigation Act (2 USCA 14)
B Treaty. Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

64 URUGUAY

A. Statute: Code on Air Legislation (Decree No. 1877 of December 3, 1942);
B. Treaty: Convention on International Civil Aviation, Chicago, December 7 1944 (U. S. treaties and other international acts, 1591, 1947).

65. VENEZUELA

A. Statute: (1) Constitution, April 11, 1953. (2) Law on Civil Aviation of June 13, 1944.

B. Treaty: Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947).

66. YUGOSLAVIA

A. Statute: (1) Law of February 22, 1928 (Sluzbene Novine of the Kingdom of the Serbs, Croats, and Slovenes, No. 50–XIII, 1928, amended by Law of January 14, 1930, ibid, No. 18–VII, 1930). (2) Decree on Civil Aviation, 1946 (Official Gazette of FPRY, No. 47, 1949).

B Treaty: (1) Convention Relating to the Regulation of Aerial Navigation, Paris, October 13, 1919, (11 League of Nations Treaty Series 173); ratified in 1926 (Sluzbene Novine of the Kingdom of the Serbs, Croats, and Slovenes, No. 8–II, 1927). (2) Convention on International Civil Aviation, Chicago, December 7, 1944 (U. S. treaties and other international acts, 1591, 1947); ratified 1953 (Official Gazette of the FPRY, Appendix—International Treaties No 3, 1954).

I would like to point out that the work of this committee—I would point out that the very elan, the very interior feeling of the legislative body which had reason to create this committee in itself is enough justification for serious consideration of these problems we have posed here today.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. This committee has received testimony to the effect that the satellites placed in orbit by the Soviet Union during the present geophysical year were probably in compliance with the usual provision made in such cases. But after the close of the geophysical year we will have another question.

What will take place, in your opinion, Mr. Haley, if no agreement is reached with the Soviet Union or the other countries of the world at the close of the geophysical year concerning research, experimentation, and the use of satellites and rockets and missiles from the standpoint of experimentation? What is going to take place?

Mr. HALEY. This is a most heartening question, because I think it is the vital problem that faces us.

And I think it should be one of the major problems for the consideration of the Committee on Astronautics and Space Exploration. In my article in the Harvard Law Record, I maintain that during the course of the international geophysical year that the nations of the world have agreed to this matter, to this proposal; but you can scarcely extend it beyond the international geophysical year, because the basis of exchange of representations was made because of the international geophysical year.

I am very much concerned that we must have at least interim understanding among the nations that these scientific explorations may continue. But we must sort of work for that end objective almost immediately.

Mr. NATCHER. What suggestions do you have to make concerning the procedure we should follow in obtaining that objective?

Should it be through the United Nations organizations? What should be the procedure?

Mr. HALEY. I personally—and I am speaking as a private citizen, of course—have a feeling that you are taking the right action now in the present bill you have proposed to enact, as at least a first measure, by utilizing the existing NACA agency and broadening it.

And I think, therefore, that we should, if possible, proceed through the United Nations. It may be necessary to call a mutilateral treatymaking proposition. But, on the other hand, we have a good forum—the United Nations—I wouldn't disagree with Mr. Fulton's proposals, but personally I would utilize the machinery of the United Nations, but not the Disarmament Commission.

Mr. NATCHER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. Mr. Haley, of course the thing I am concerned with in this matter is how far do you propose that we go—and I am speaking now unilaterally—to set up rules and regulations for our own use or benefit in the control and launching of satellites or space exploration or of the landing or taking off of spaceships, as a unilateral proposition?

That is, I mean how far do you anticipate that we can go without some type of multilateral program developing?

Mr. HALEY. That is the point. Of course, all I can say now is pretty primitive.

I can say that I am thoroughly happy with the creation of this Committee on Astronautics and Space Exploration and the hearings you have held, and so on, and your proposals for investigation of problems. But certain problems have not yet arisen.

I think you should have study groups to consider the future problems of space travel and of the earth-to-earth, or point-to-point earth-rocket travel. And I think that you are providing for that—so I do not think you can do anything more at the present time unilaterally than to study the inevitable problems and be prepared to handle such problems on the basis of sound solutions. Law must precede man into space.

Mr. SISK. Well, I appreciate your statement. And looking over some of the background here, I, of course, am familiar with the fact, and I understand it, that you are quite recognized in the field of this type of law which is still in its infancy, to some extent. Yet we have in the immediate future a problem facing us.

And realizing the difficulties involved in international agreements of any kind today, with reference to attempts to disarm, and so on, I can foresee, let's say, next year, a possibility arising. And I was curious whether you had any recommendations on how far you would go in setting up a specific regulation?

Mr. HALEY. Mr. Sisk, you gave me the finest question that I could have and I thoroughly muffed it. I apologize.

I can give you an example that is so cogent and right down the line of your thinking that it is amazing that I am so stupid as not to grasp your question immediately.

That is the question of radio regulation.

Right now under the thesis that there has been a subsisting treaty—at least an agreement among nations—whereby the orbiting is lawful; by the same token you cannot do anything unlawful in orbiting. In other words, you cannot violate the treaties of the world; you cannot violate the domestic municipal law of any nation, and so on.

The first violation in space law occurred in connection with Sputnik I and II. This matter is within the realm of my own expertise, so to speak, for 30 years. The Russians used the frequency 20.005 megacycles, and the frequency 40.002 megacycles for dissemination of signals from satellites to earth.

Now, under valid existing treaties, the International Telecommunications Convention, to which Russia is a signatory, you must file at Geneva your choice of—the selection of frequencies and the proposed use. And you must not select any frequency that has already been filed upon and which will conflict with the allocations made by the ITU—the International Telecommunications Union.

So, what happened?

The Russian Sputnik, No. I, violated the use of 20.005 by one of the most essential United States station, namely, WWV, in Maryland, which is the great calibration station of the United States.

In other words, it is almost impossible for me to describe its importance, because it is the time signal station, timed to the sixth digit.

It is a station that calibrates meters—electronic meters, radio meters—and a thousand other things which are essential to the scientific community of America, and this station should not be interfered with.

All right, that is only one example. Others I won't take the time of the committee in describing.

40.002, another channel, that is used in region 2 of the world—I think that is in southern Asia—for radio dissemination in connection with the safety of life and property in the air, you see. And there it might have caused interference.

And there are claims of interference in other parts of the world; which I won't go into.

I have it all written out. I won't bore the committee with it.

Now, another thing is that RCA in New York and the Australian Government simultaneously recorded on tape a signal on 14.836, or some 14-something, megacycles which appeared to be a questioning signal from the Soviet to the satellite.

In other words, this signal seemed to be asking for information from the satellite, and receiving information from the satellite station, you see. What goes on: That is the sort of signal.

Now, we know nothing about this other than the very strange concomitance of two great radio centers hearing the signal at the same time.

That use, of course, would be another violation.

So already we have violations of space law. And I must say that these violations are receiving the active attention of our governmental agencies. And that the whole problem of space law in this field is being attended to as best they can by our governmental agencies. For example, the Federal Communications Commission has two proceedings pending. And it has issues in each proceeding concerning the use of radio signals for space purposes. And I have appeared on both those proceedings And these are justifiable proceedings. So there we are doing something nationally.

Also the State Department has a working group preparatory to the revision of the 1959 Radio Convention in Geneva, looking now into the communications problems of space travel. I think this is one of the duties of this committee to look into this too.

Mr. SISK. I yield to counsel.

Mr. FELDMAN. Mr. Haley, in your prepared statement you stated that under the International Geophysical Year—and correct me, if I am wrong—that we had something in the nature of an international pact, and that was, in effect, an agreement.

Now, if that, in effect, was an agreement, then under it, the sending up of the sputniks could be justified. Is that not so?

Mr. HALEY. That is my point exactly

Mr. FELDMAN. Well, then, can you reconcile the statement that it was justified with your reply to Congressman Sisk's question just now and say that was a violation of an international agreement?

Mr. HALEY. No.

Thank you for giving me the opportunity to clarify that point. What I said—at least what I should have said—was that sending up the sputnik was justified—Sputnik, the object itself, you see. But by the very fact of its legality there was a concomitant duty on the part of the persons who sent it up to obey the laws of all nations, other laws.

Now, there are thousands of other laws. One of them is the laws relating to radio disseminations. Radio disseminations really have nothing to do essentially by themselves in the orbital object going around. But if they use that object for an unlawful purpose or if they use it unlawfully, then they have violated space law.

Mr. FELDMAN. That isn't quite clear to me.

Mr. FULTON. Actually what you mean, Mr. Haley, is that where there is no rule or regulation already set out in outer space, there probably is, by custom, already established among the nations through the IGY, a set of rules.

But you also made the point that, where there is at present an international agreement, such as under the Telecommunications Union, and there are regulations already set up, there has been a violation in that field.

Mr. HALEY. That is right, that field alone.

Mr. FULTON. You were referring to two separate fields?

Mr. HALEY. That is right.

Mr. FELDMAN. Well, that would be one rationale. But the other could also be that once you say this was legal, once you say they had the authority to send this up, then you can also conclude that they had the right to do so. Under the Geophysical Year they had the authority, implied authority, to transmit the messages as they saw fit, providing they make those available eventually to the scientific community.

You can take both sides of that question, and you can not resolve it. You can not resolve it by saying that you disagree, because there is just as potent an argument on one side as there is on the other.

Mr. HALEY. I disagree with that too. Your flag carries a responsibility.

Mr. FELDMAN. I don't see where that is an answer to it at all. I can see perfectly clear that we are getting into a hairsplitting argument here. The reason we are getting into it is because there is a basis for both sides.

Mr. HALEY. Yes, sir. The view may well be taken that all treaty law must be specifically extended to outer space—this view is quite valid.

Mr. FELDMAN. And because you have a basis for both sides you may not be able to resolve the fact. We know this in law, for example, that where there is a dispute on a scientific question, and where there is a difference of opinion between the two, you can not resolve the fact. That must be precisely the situation here.

Mr. SISK. Mr. Chairman, as a layman over here, if I can make a comment. I realize these two lawyers here, of course, can have a difference of opinion. I have many very fine friends who are lawyers. But as a layman, I would understand from Mr. Haley's answers, if I may be able to give a layman's example, that I am permitted, if I own an automobile and have a license, to drive it on the highways, but I am still required to comply with the rules of the road while operating the vehicle.

Is that an oversimplified explanation of your position, Mr. Haley? That Russia had a right under IGY agreements to launch a satellite; but that there were certain rules and regulations, rules of the road, so to speak, that they were supposed to comply with in the use of it? Is that applicable at all?

Mr. HALEY. That is one sound viewpoint, but Mr. Feldman also has a very good argument.

Mr. FELDMAN. All I am saying is that there is room for the other side.

Mr. SISK. I might say, of course, Mr. Haley, I have great respect for Mr. Feldman. He has done a great job for us. I am not agreeing or disagreeing with either of you gentlemen. I am trying to clarify in my own mind what I understood to be your position.

Mr. HALEY. That is my position. Mr. Feldman is indeed most competent and he also has a position which is highly defensible, and I concede he may be quite right.

Mr. SISK. Your position is that they had the right, more or less, under an international agreement, to launch a satellite, but they could still be required to comply with international law, for instance, in radio transmission or other uses.

Mr. HALEY. That is my point. On the other hand Mr. Feldman may be 100 percent correct, in that in outer space no law prevails and it may be necessary first to arrive at a system of treaty law before any violations may be said to occur.

Mr. FELDMAN. What could we do about it, if we wanted to do something?

Mr. SISK. That was the key question I had.

But, Mr. Chairman, that is all I have at the present time.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. I think there is a further point we should consider in line with the colloquy between you and Mr. Feldman. And that is as to the field of space flight by agreement under the IGY where it was preliminary agreed with Russia that the sputniks, Explorers, and Vanguards, for example, would go to a certain height.

I believe that, actually, when the Russians put their sputniks in the air—we have had previous testimony here that they went to a higher level than was either agreed upon or that the other nations expected. So if you are basing your philosophy on the fact that there was an agreement among nations through respected and authoritative bodies, rather than governmental bodies, in many cases, I would think that the agreements would have to be on what was intended and not just what happened. Possibly I think Congressman McCormack and I would both agree that even in the field of space flight there was possibly a violation to begin with by Russia on what was agreed as to the height of the sputniks.

Is that not right?

Mr. HALEY. I think so, yes.

Mr. FULTON. So that you might start on space travel with a violation on space flight as well as on telecommunications.

Mr. HALEY. I think that is a very important statement you are making, because after all if somebody posted a satellite at 22,500 feet orbiting over the earth, just watching Washington, that would be—at that point it could become stationary as far as Washington is concerned.

That is one of the problems that you face, you see.

Mr. FULTON. Another point is this: When Sputnik No. 1 was put in the air, the purpose was known. But as far as we were able to determine there was no communication of the intent or its practical use, so that we in the other countries, including the United States, didn't know what the scientific implementation was, did we?

Mr. HALEY. You are exactly right about that statement. We still don't know the answer to it.

We have statements back and forth. We have a lot of information.

Mr. FULTON. When we are looking at violations of the telecommunications point, actually under the agreements of the IGY. Any nation has until 1 year after the event to make known its full scientific information and results. Is that not correct?

Mr. HALEY. That is correct.

Mr. FULTON. So far as Russia releasing materials, she has been doing as she has been doing all along. Russia is, therefore, not technically in violation of any agreement under the Geophysical Year on the point of releasing scientific information.

Mr. HALEY. That is right.

Mr. FULTON. Then, on section 2 of article 2 of the United States Constitution, the power is given to the President of the United States, with the advice and consent of two-thirds of the Senate, to make treaties. There has, in addition to that, grown up a form of executive agreement. Under this, we in the United States, through agreements of less than treaty status, have certain pacts that are in operation and effect concerning various fields of lesser importance.

Are you inferring that the IGY type of agreement is of the treaty level? Or do you keep it down to the executive agreement level?

Mr. HALEY. I take it—that is a very good question. It certainly is not the treaty level. And it certainly is not in the executive-agreement level. It is part of the method of growth of international law, such as the law of the sea which is observed by all nations.

Mr. FULTON. May I then bring up this question.

In the common law which we have inherited, there is the basic rule of law that there is a basic unit. But we look in each separate instance to find what that unit is on an unwritten-law basis. Do you agree with that?

Mr. HALEY. Yes; I do.

Mr. FULTON. So that you really are saying that this is to be added——

The CHAIRMAN. Well, what about the uses of customs which develop into common law?

Mr. FULTON. That is a good point.

The CHAIRMAN. What customs have we got here that can develop a common-law status?

Mr. HALEY. That is the point of the Harvard article—the customs. This is by consent.

Mr. FULTON. I might say that I am speaking as a private citizen. I went to Harvard Law.

Mr. HALEY. I wanted to give you the reference to the articles.

Mr. FULTON. The point I am coming to is this: Shouldn't Congress have some statement of our intention in the United States as to what we will use outer space for, a statement of peaceful purposes.

Should we not begin with that basis?

Mr. HALEY. Absolutely.

Mr. FULTON. Then shouldn't we in this Congress say, by resolution, that we feel that this is important enough to have a national space agency to implement a national space policy?

Mr. HALEY. Exactly so.

Mr. FULTON. Then shouldn't we likewise say that we feel that the ramifications of it automatically go into international law of one kind or another. Shouldn't we recommend to the President that he proceed through the United Nations or other agencies, or multilateral international agreements arrived at a conference, to get some international agreement on the method for exploring outer space for the benefit of mankind.

Wouldn't you say that?

Mr. HALEY. I think you are expressing it far better than I could. It is what I want to say.

Mr. FULTON. You would agree with that?

Mr. HALEY. Absolutely. I not only agree with it, but I think it is expressing it in a perfect manner, yes.

Mr FULTON. Then, when we come to that point, we must decide what the Space Agency shall do. You would agree that it should be a civilian space agency, would you not?

Mr. HALEY. Oh, yes, by all means. I wouldn't limit the military, though, as a matter of fact The military function is something separate and distinct. The military should have all the support and freedom it needs to defend our country.

Mr. FULTON. As a matter of fact, in the legislation as drawn, on line 7 of page 2, it excepts specificially the activities as they may be peculiar to or primarily associated with weapons systems or military programs.

So you would agree with that.

Mr. HALEY. I agree with that absolutely.

Mr. FULTON. Now that brings up this point of difference between you and our good friend Loftus Becker. He refers to article 51 of the United Nations Charter and thinks that that might be the basis for a defensive approach to outer space. But isn't the problem both civilian research and development and exploration, as well as defensive?

And then shouldn't we proceed on both elements, one on the civilian and the second on defensive if we took either one, we are making a mistake, are we not?

Mr. HALEY. Well, absolutely. That is as logical as anything could be. The CAB, and the CAA, those two agencies don't interfere with the military. They still have an essential function to perform, just like the agency you are talking about has an essential function to perform.

Mr. FULTON. On that end of it, when I asked Mr. Becker yesterday about what there might be previously to give Congress the right to go into outer space, presuming it was on a civilian basis, he had spoken of the commerce power.

Now, that is section 8 of article 1 of the Constitution where Congress has the power to regulate commerce with foreign nations and among States.

You wouldn't base our policy that narrowly, that we were simply going out under the commerce power of the Constitution, because that is too narrow a civilian point of view, is it not?

Mr. HALEY. I think so, yes. The commerce clause is pertinent but by itself, altogether too narrow.

Mr. FULTON. Would you have this civilian Space Agency set up as one director or as a commission form?

Mr. HALEY. At the present time I think we stand on the same situation as in 1910 with respect to radio, you see. I think what you are doing now is all right for now. But this is a first step. Later on when we have point-to-point rocket operations on the earth itself, when we have some civilian uses for satellites and outer space and so on—which won't be too long from now—then we will have to have commissions set up such as we now have with respect to the CAB and the CAA.

And I don't think that an advisory board like NACA would be effective later on. It is all right now.

Mr. FULTON. That brings me to my final point.

You do recommend Congress setting up a national space agency.

Mr. HALEY. Yes.

Mr. FULTON. Because we are going to be asked by other Members of the Congress and by taxpayers why not let it go just as it is and why run into the expense and the added redtape of a new agency.

Do you believe there should be a new separate agency, a space agency?

Mr. HALEY. No; I didn't say that. I said at the present time we should proceed with the program that you have undertaken under the law here, under the bill here.

Mr. FULTON. The point is shall we set up a national space agency as a separate agency or simply leave it in the NACA as it now exists?

The CHAIRMAN. You have read the bill, have you?

Mr. HALEY. Yes.

The CHAIRMAN. You mean you realize that this is terminating the NACA and using its facilities.

Mr. HALEY. Of course I realize that; yes.

The CHAIRMAN. And as the facilities and so forth—well, as the chief counsel says, the building block of the new agency—it is going to use that.

Mr. HALEY. Yes; I realize that. I think that is good.

Mr. FULTON. But you think it is important and urgent enough that we should proceed immediately to the setting up of a national space agency.

Mr. HALEY. Absolutely. I think it is essential.

Mr. FULTON. Thank you. That is all.

The CHAIRMAN. Any questions, Mr. Brooks?

Mr. BROOKS. No questions.

The CHAIRMAN. Mr. Feldman.

Mr. FELDMAN. Let me get back to your statement on page 13, that under international law no nation may protest the flight overhead of a scientific satellite.

This, at least in my opinion, is highly debatable. And Professor Cooper does not agree with this point of view. Sir Wilfred Jenks, on the other hand, has said the same thing on the basis of a tacit agreement and practice connected with the United States and Soviet satellites. Certainly, there is no treaty or executive agreement.

And Mr. Becker says that this tacit agreement is limited to the period of the IGY, since the advance announcements of the satellite launchings were so limited.

Now, the Cooper-Becker position seems to be legally sound.

On the other hand, you and Sir Wilfred Jenks may have been influenced by the fact that you want outer space to be free to all nations for peaceful uses.

Mr. HALEY. Yes; that is correct.

Mr. FELDMAN. And then, of course, there is also the analogy from the law of the seas, namely, the radio law that you have just alluded to. Now, I understand that you have attended a great many of the international conferences in this field for many years.

Mr. HALEY. All of them.

Mr. FULTON. And at those conferences have you had contact with representatives from the Iron Curtain countries, particularly Russia? Have they discussed scientific matters at those conferences?

Mr. HALEY. That is a very good question. I would be very happy to answer it.

Here is U. S. A.–U. S. S. R., you see. Well, the first time that Professor Leonid Sedov, Chairman of the Astronomical Unit of the Academy of Sciences, U. S. S. R.—Professor Sedov—let's say he sits here. We are both together all the time at these conferences.

The first Congress he came to was at Copenhagen in 1955, just after President Eisenhower announced the satellite program.

They invited the chiefs of delegations to the Soviet Embassy. And I went there as chief of the American Rocket Society, the American delegation.

Professor Ogorodnikov, who was chief astronomer at Leningrad, said that—he volunteered on that occasion that he had already calculated the orbit of a satellite.

The CHAIRMAN. The question was: Was there a free exchange of conversation of views?

Mr. HALEY. Not exactly. As far as I was concerned on no occasion in any Congress have I ever asked a question of any Iron Curtain delegate. I never asked any questions. I did not want to be impertinent, you see, in the sense of putting them on the spot.

The CHAIRMAN. Well, I would do it.

Mr. HALEY. Yes. But I was an official of the entire organization.

The CHAIRMAN. There are various ways of finding out both affirmatively and negatively. You can learn information in many ways.

Mr. HALEY. I just wanted to make the point that I do not ask what might be considered to be impertinent questions.

The CHAIRMAN. Did you find a cooperative spirit?

Mr. HALEY. No.

The CHAIRMAN. There was a holding back?

Mr. HALEY. Just a silence.

But there was, however, enough information for us to have realized what Russia was doing.

The CHAIRMAN. Well, you can learn from silence.

Mr. HALEY. That is what I will tell you. The first thing was that Ogorodnikov said he had calculated the satellite orbit.

The CHAIRMAN. If we are going to vote for a certain bill and you look at me and don't say anything, I am learning something. I say, well, I have got a little difficulty there.

Mr. HALEY. That is the reason you are the leader of the House.

On that Congress we learned that they had calculated the orbit of a satellite.

Mr. FELDMAN. When was that?

Mr. HALEY. 1955, just after the announcement of President Eisenhower.

Mr. FULTON. Who said it?

Mr. HALEY. Professor Ogorodnikov, just a few days after the President's announcement. Nobody paid a darned bit of attention to it as far as I was concerned. To me it was an immense fact. I reported it all over. But I was told "the Russians are boasting again."

The CHAIRMAN. They weren't taking you in; were they? I mean not you but——

Mr. HALEY. Well.

Then, to return their compliment, I gave a party for them with the chiefs of delegations in my suite in my hotel.

Professor Sedov, who was Chairman of the Astronautical Commission of the Academy of Science of the U. S. S. R., made a few remarks stating the fact that they thought that this was no great problem; that they had enough basic things in the works to put a satellite up, and they were very happy that Mr. Khrushchev had approved the program. They had been permitted for the first time to come to our meetings, you see. So they wanted to collaborate in this IGY proposition.

All right, their next episode was——

Mr. FULTON. What was the date of that?

Mr. HALEY. 1955.

Mr. FULTON. What time of the year?

Mr. HALEY. August. Just after the President's announcement. That was July 29, I think. About 10 days after. This was the first time they had come, you see.

This is the old story of the barn door being opened and the horse leaving, and so on.

So, in Rome in 1956, Professor Sedov said that he thought our proposed satellite was very small, and that the Soviet satellite would be much larger. And he said that he thought we were having long delays. And there was no reason why there shouldn't be a satellite launched very soon, you see.

This again was, to me, immense news. And simple news, but immense. If you want to expand upon it a thousand different ways, you still come back to the same thing. Our satellite was too small; their's was larger; we were too slow; they would be faster, you see. That drew comments from various sources that "Oh, they are boasting again, you see."

They are still boasting.

Of course, the next episode of the International Conference was in—on the way with Dr. von Karman we heard the news in Toulouse that the sputnik was out in outer space.

But now the concomitance of these things is such that there should have been absolutely no—if they were critically analyzed there should have been no doubt in the minds of the officials, the appropriate officials of America, that the Russians were going to launch a satellite and they were going to launch a big satellite.

Mr. BROOKS. We were just overconfident, a little blase.

Mr. HALEY. To say the least, yes.

The CHAIRMAN. Mr. Haley, of course we all know, whether lawyers or nonlawyers, there is the law of self-preservation. That is the leading question that anyone can answer. And, of course, until there are satisfactory international arrangements made we cannot ignore the law of self-preservation in the national interest and security of our own country. That is so, isn't it?

Mr. HALEY. I should say it is so.

The CHAIRMAN. The importance of the military is always great. Particularly in days like this we cannot ignore the significance in the terms of not only our own preservation but the preservation of a culture and ideals and principles, and the deepest things we stand for—the intangibles

That is true, isn't it?

Mr. HALEY. I would agree with that.

The CHAIRMAN. These questions don't contradict anything you have said. You recognize that the field of international settlement is a long one; and as in other human matters, an ever-changing and an endless one But precedent helps future negotiations, and conversations, and negotiations, and so forth.

But during that we cannot—we must always at all times recognize the law of necessity which follows the law of self-preservation.

That is correct, isn't it?

Mr. HALEY. That is absolutely correct. That is what bothered me about the testimony yesterday. Because I think that we will soon—soon we will become a second-rate nation overnight unless we are well ahead in the technology for peaceful purposes for mankind everywhere.

The CHAIRMAN. But during that period, we cannot ignore the exigencies of the law of self-preservation.

Mr. HALEY. I certainly agree with that statement.

The CHAIRMAN. Any further questions?

(No response.)

The CHAIRMAN. Thank you very much, Mr. Haley. We have enjoyed your appearance before us.

The next witness is Mr. Leonard Niederlehner of the Department of Defense.

I understand that you have Col. Sidney Rubenstein, Deputy Director of Personnel Security Policy, with you.

Do you want to start off like a panel? We like the informal atmosphere because we think we get more information.

We are very glad to have both of you gentlemen with us.

Do you have prepared statements?

Mr. NIEDERLEHNER. We do not, Mr. Chairman. I was notified just this morning. If you will give me an indication of what you

would like to have me address myself to, I think I can do it without a formal statement.

Mr. FELDMAN. The purpose of having these two gentlemen here this morning is so we can have the directives concerning the classification and declassification of classified material in the record. And also an explanation in a general way of how material is classified and unclassified.

Do you have those records with you, sir?

Mr. NIEDERLEHNER. I do; yes, sir.

STATEMENT OF LEONARD NIEDERLEHNER[42] DEPUTY GENERAL COUNSEL, DEPARTMENT OF DEFENSE, ACCOMPANIED BY COL. SIDNEY S. RUBENSTEIN. DEPUTY DIRECTOR, PERSONNEL SECURITY POLICY OFFICE OF THE SECRETARY OF DEFENSE

Mr. NIEDERLEHNER. I think, perhaps, from the committee's point of view, you would be interested in the distinction between the classification system which applies in the Department of Defense, for example, and that in the Atomic Energy Commission.

In the Atomic Energy Commission there is a specific legal basis for the classification of restricted data.

Mr. FELDMAN. A provision.

Mr. NIEDERLEHNER. In the Department of Defense, the authority to classify is derivative, and is based upon a number of much more general provisions of the law. The specific basis upon which the system is now working is an Executive order of the President which is numbered Executive Order 10501, dated November 5, 1953. This, in turn, is elaborated and applied within the Department of Defense in a Department of Defense directive applicable throughout the entire Department. It is numbered 5200.1. And this is dated July 8, 1957.

Regarding the general basis of the classification of information, there are a number of background provisions of law and the Constitution which are generally pointed to as the basis for this classification of defense information.

First is a housekeeping statute which makes the head of an agency responsible for the preservation of the material which is entrusted to his care by virtue of the fact that he is the head of the agency.

The CHAIRMAN. Is that the old statute?

Mr. NIEDERLEHNER. That is the old title 5, United States Code, section 22. This is one of the bases of the responsibility of the head of the agency for the preservation of information.

There is also the Espionage Act, which is title 18, United States Code, section 793, and the following sections. This statute makes a criminal offense of the release of certain information to unauthorized persons. And from that you draw the substantial inference that the individual who has custody must preserve it.

I think you could go further back into the general responsibility of the Commander in Chief, for example, to preserve military information because military information by its very nature in relation to

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conduct of warfare must be preserved to prevent an advantage to a potential enemy.

If you wish, I will offer for the record the Executive order of 1953.

The CHAIRMAN. Without objection it will be made a part of the record.

(The above-mentioned order follows:)

EXECUTIVE ORDER NO. 10501, NOVEMBER 5, 1953, SAFEGUARDING OFFICIAL INFORMATION IN THE INTERESTS OF THE DEFENSE OF THE UNITED STATES

Whereas it is essential that the citizens of the United States be informed concerning the activities of their government; and

Whereas the interests of national defense require the preservation of the ability of the United States to protect and defend itself against all hostile or destructive action by covert or overt means, including espionage as well as military action; and

Whereas it is essential that certain official information affecting the national defense be protected uniformly against unauthorized disclosure:

Now, therefore, by virtue of the authority vested in me by the Constitution and statutes, and as President of the United States, and deeming such action necessary in the best interests of the national security, it is hereby ordered as follows:

SECTION 1. CLASSIFICATION CATEGORIES

Official information which requires protection in the interests of national defense shall be limited to three categories of classification, which in descending order of importance shall carry one of the following designations: Top Secret, Secret, or Confidential. No other designation shall be used to classify defense information, including military information, as requiring protection in the interests of national defense, except as expressly provided by statute. These categories are defined as follows:

(a) *Top Secret.* Except as may be expressly provided by statute, the use of the classification Top Secret shall be authorized, by appropriate authority, only for defense information or material which requires the highest degree of protection. The Top Secret classification shall be applied only to that information or material the defense aspect of which is paramount, and the unauthorized disclosure of which could result in exceptionally grave damage to the Nation such as leading to a definite break in diplomatic relations affecting the defense of the United States, an armed attack against the United States or its allies, a war, or the compromise of military or defense plans, or intelligence operations, or scientific or technological developments vital to the national defense.

(b) *Secret.* Except as may be expressly provided by statute, the use of the classification Secret shall be authorized, by appropriate authority, only for defense information or material the unauthorized disclosure of which could result in serious damage to the Nation, such as by jeopardizing the international relations of the United States, endangering the effectiveness of a program or policy of vital importance to the national defense, or compromising important military or defense plans, scientific or technological developments important to national defense, or information revealing important intelligence operations.

(c) *Confidential.* Except as may be expressly provided by statute, the use of the classification Confidential shall be authorized, by appropriate authority, only for defense information or material the unauthorized disclosure of which could be prejudicial to the defense interests of the nation.

SECTION 2. LIMITATION OF AUTHORITY TO CLASSIFY

The authority to classify defense information or material under this order shall be limited in the departments and agencies of the executive branch as hereinafter specified. Departments and agencies subject to the specified limitations shall be designated by the President:

(a) In those departments and agencies having no direct responsibility for national defense there shall be no authority for original classification of information or material under this order.

(b) In those departments and agencies having partial but not primary responsibility for matters pertaining to national defense the authority for original classification of information or material under this order shall be exercised only by the head of the department or agency, without delegation.

(c) In those departments and agencies not affected by the provisions of subsections (a) and (b), above, the authority for original classification of information or material under this order shall be exercised only by responsible officers or employees, who shall be specifically designated for this purpose. Heads of such departments and agencies shall limit the delegation of authority to classify as severely as is consistent with the orderly and expeditious transaction of Government business.

SECTION 3. CLASSIFICATION

Persons designated to have authority for original classification of information or material which requires protection in the interests of national defense under this order shall be held responsible for its proper classification in accordance with the definitions of the three categories in section 1, hereof. Unnecessary classification and over-classification shall be scrupulously avoided. The following special rules shall be observed in classification of defense information or material:

(a) *Documents in General:* Documents shall be classified according to their own content and not necessarily according to their relationship to other documents. References to classified material which do not reveal classified defense information shall not be classified.

(b) *Physically Connected Documents:* The classification of a file or group of physically connected documents shall be at least as high as that of the most highly classified document therein. Documents separated from the file or group shall be handled in accordance with their individual defense classification.

(c) *Multiple Classification:* A document, product, or substance shall bear a classification at least as high as that of its highest classified component. The document, product, or substance shall bear only one over-all classification, notwithstanding that pages, paragraphs, sections, or components thereof bear different classifications.

(d) *Transmittal Letters:* A letter transmitting defense information shall be classified at least as high as its highest classified enclosure.

(e) *Information Originated by a Foreign Government or Organization:* Defense information of a classified nature furnished to the United States by a foreign government or international organization shall be assigned a classification which will assure a degree of protection equivalent to or greater than that required by the government or international organization which furnished the information.

SECTION 4. DECLASSIFICATION, DOWNGRADING, OR UPGRADING

Heads of departments or agencies originating classified material shall designate persons to be responsible for continuing review of such classified material for the purpose of declassifying or downgrading it whenever national defense considerations permit, and for receiving requests for such review from all sources. Formal procedures shall be established to provide specific means for prompt review of classified material and its declassification or downgrading in order to preserve the effectiveness and integrity of the classification system and to eliminate accumulation of classified material which no longer requires protection in the defense interest. The following special rules shall be observed with respect to changes of classification of defense material:

(a) *Automatic Changes:* To the fullest extent practicable, the classifying authority shall indicate on the material (except telegrams) at the time of original classification that after a specified event or date, or upon removal of classified enclosures, the material will be downgraded or declassified.

(b) *Non-Automatic Changes:* The persons designated to receive requests for review of classified material may downgrade or declassify such material when circumstances no longer warrant its retention in its original classification provided the consent of the appropriate classifying authority has been obtained. The downgrading or declassification of extracts from or paraphrases of classified documents shall also require the consent of the appropriate classifying authority unless the agency making such extracts knows positively that they warrant a classification lower than that of the document from which extracted, or that they are not classified.

(c) *Material Officially Transferred:* In the case of material transferred by or pursuant to statute or Executive order from one department or agency to another for the latter's use and as part of its official files or property, as distinguished from transfers merely for purposes of storage, the receiving department or agency shall be deemed to be the classifying authority for all purposes under this order, including declassification and downgrading.

(d) *Material Not Officially Transferred:* When any department or agency has in its possession any classified material which has become five years old, and it appears (1) that such material originated in an agency which has since become defunct and whose files and other property have not been officially transferred to another department or agency within the meaning of subsection (c), above, or (2) that it is impossible for the possessing department or agency to identify the originating agency, and (3) a review of the material indicates that it should be downgraded or declassified, the said possessing department or agency shall have power to declassify or downgrade such material. If it appears probable that another department or agency may have a substantial interest in whether the classification of any particular information should be maintained, the possessing department or agency shall not exercise the power conferred upon it by this subsection, except with the consent of the other department or agency, until thirty days after it has notified such other department or agency of the nature of the material and of its intention to declassify or downgrade the same. During such thirty-day period the other department or agency may, if it so desires, express its objections to declassifying or downgrading the particular material, but the power to make the ultimate decision shall reside in the possessing department or agency

(e) *Classified Telegrams:* Such telegrams shall not be referred to, extracted from, paraphrased, downgraded, declassified, or disseminated, except in accordance with special regulations issued by the head of the originating department or agency. Classified telegrams transmitted over cryptographic systems shall be handled in accordance with the regulations of the transmitting department or agency.

(f) *Downgrading:* If the recipient of classified material believes that it has been classified too highly, he may make a request to the reviewing official who may downgrade or declassify the material after obtaining the consent of the appropriate classifying authority.

(g) *Upgrading* If the recipient of unclassified material believes that it should be classified, or if the recipient of classified material believes that its classification is not sufficiently protective, it shall be safeguarded in accordance with the classification deemed appropriate and a request made to the reviewing official, who may classify the material or upgrade the classification after obtaining the consent of the appropriate classifying authority.

(h) *Notification of Change in Classification.* The reviewing official taking action to declassify, downgrade, or upgrade classified material shall notify all addressees to whom the material was originally transmitted.

SECTION 5. MARKING OF CLASSIFIED MATERIAL

After a determination of the proper defense classification to be assigned has been made in accordance with the provisions of this order, the classified material shall be marked as follows:

(a) *Bound Documents:* The assigned defense classification on bound documents, such as books or pamphlets, the pages of which are permanently and securely fastened together, shall be conspicuously marked or stamped on the outside of the front cover, on the title page, on the first page, on the back page and on the outside of the back cover. In each case the markings shall be applied to the top and bottom of the page or cover.

(b) *Unbound Documents:* The assigned defense classification on unbound documents, such as letters, memoranda, reports, telegrams, and other similar documents, the pages of which are not permanently and securely fastened together, shall be conspicuously marked or stamped at the top and bottom of each page, in such manner that the marking will be clearly visible when the pages are clipped or stapled together.

(c) *Charts, Maps, and Drawings:* Classified charts, maps, and drawings shall carry the defense classification marking under the legend, title block, or scale in such manner that it will be reproduced on all copies made therefrom. Such classification shall also be marked at the top and bottom in each instance.

(d) *Photographs, Films and Recordings:* Classified photographs, films, and recordings, and their containers, shall be conspicuously and appropriately marked with the assigned defense classification.

(e) *Products or Substances:* The assigned defense classification shall be conspicuously marked on classified products or substances, if possible, and on their containers, if possible, or, if the article or container cannot be marked, written notification of such classification shall be furnished to recipients of such products or substances.

(f) *Reproductions:* All copies of reproductions of classified material shall be appropriately marked or stamped in the same manner as the original thereof.

(g) *Unclassified Material:* Normally, unclassified material shall not be marked or stamped *Unclassified* unless it is essential to convey to a recipient of such material that it has been examined specifically with a view to imposing a defense classification and has been determined not to require such classification.

(h) *Change or Removal of Classification:* Whenever classified material is declassified, downgraded, or upgraded, the material shall be marked or stamped in a prominent place to reflect the change in classification, the authority for the action, the date of action, and the identity of the person or unit taking the action. In addition, the old classification marking shall be cancelled and the new classification (if any) substituted therefor. *Automatic* change in classification shall be indicated by the appropriate classifying authority through marking or stamping in a prominent place to reflect information specified in subsection 4 (a) hereof.

(i) *Material Furnished Persons not in the Executive Branch of the Government:* When classified material affecting the national defense is furnished authorized persons, in or out of Federal service, other than those in the executive branch, the following notation, in addition to the assigned classification marking, shall whenever practicable be placed on the material, on its container, or on the written notification of its assigned classification:

"This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U. S. C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law."

Use of alternative marking concerning "Restricted Data" as defined by the Atomic Energy Act is authorized when appropriate.

SECTION 6. CUSTODY AND SAFEKEEPING

The possession or use of classified defense information or material shall be limited to locations where facilities for secure storage or protection thereof are available by means of which unauthorized persons are prevented from gaining access thereto. Whenever such information or material is not under the personal supervision of its custodian, whether during or outside of working hours, the following physical or mechanical means shall be taken to protect it:

(a) *Storage of Top Secret Material:* Top Secret defense material shall be protected in storage by the most secure facilities possible. Normally it will be stored in a safe or a safe-type steel file container having a three-position, dial-type, combination lock, and being of such weight, size, construction, or installation as to minimize the possibility of surreptitious entry, physical theft, damage by fire, or tampering. The head of a department or agency may approve other storage facilities for this material which offer comparable or better protection, such as an alarmed area, a vault, a secure vault-type room, or an area under close surveillance of an armed guard.

(b) *Secret and Confidential Material:* These categories of defense material may be stored in a manner authorized for Top Secret material, or in metal file cabinets equipped with steel lockbar and an approved three combination dial-type padlock from which the manufacturer's identification numbers have been obliterated, or in comparably secure facilities approved by the head of the department or agency.

(c) *Other Classified Material:* Heads of departments and agencies shall prescribe such protective facilities as may be necessary in their departments or agencies for material originating under statutory provisions requiring protection of certain information.

(d) *Changes of Lock Combinations:* Combinations on locks of safekeeping equipment shall be changed, only by persons having appropriate security

clearance, whenever such equipment is placed in use after procurement from the manufacturer or other sources, whenever a person knowing the combination is transferred from the office to which the equipment is assigned, or whenever the combination has been subjected to compromise, and at least once every year. Knowledge of combinations shall be limited to the minimum number of persons necessary for operating purposes. Records of combinations shall be classified no lower than the highest category of classified defense material authorized for storage in the safekeeping equipment concerned.

(e) *Custodian's Responsibilities*: Custodians of classified defense material shall be responsible for providing the best possible protection and accountability for such material at all times and particularly for securely locking classified material in approved safekeeping equipment whenever it is not in use or under direct supervision of authorized employees. Custodians shall follow procedures which insure that unauthorized persons do nor gain access to classified defense information or material by sight or sound, and classified information shall not be discussed with or in the presence of unauthorized persons.

(f) *Telephone Conversations*: Defense information classified in the three categories under the provisions of this order shall not be revealed in telephone conversations, except as may be authorized under section 8 hereof with respect to the transmission of Secret and Confidential material over certain military communications circuits.

(g) *Loss or Subjection to Compromise*: Any person in the executive branch who has knowledge of the loss or possible subjection to compromise of classified defense information shall promptly report the circumstances to a designated official of his agency, and the latter shall take appropriate action forthwith, including advice to the originating department or agency.

SECTION 7. ACCOUNTABILITY AND DISSEMINATION

Knowledge or possession of classified defense information shall be permitted only to persons whose official duties require such access to the interest of promoting national defense and only if they have been determined to be trustworthy. Proper control of dissemination of classified defense information shall be maintained at all times, including good accountability records of classified defense information documents, and severe limitation on the number of such documents originated as well as the number of copies thereof reproduced. The number of copies of classified defense information documents shall be kept to a minimum to decrease the risk of compromise of the information contained in such documents and the financial burden on the Government in protecting such documents. The following special rules shall be observed in connection with accountability for and dissemination of defense information or material:

(a) *Accountability Procedures:* Heads of departments and agencies shall prescribe such accountability procedures as are necessary to control effectively the dissemination of classified defense information, with particularly severe control on material classified Top Secret under this order. Top Secret Control Officers shall be designated, as required, to receive, maintain accountability registers of, and dispatch Top Secret material.

(b) *Dissemination Outside the Executive Branch:* Classified defense information shall not be disseminated outside the executive branch except under conditions and through channels authorized by the head of the disseminating department or agency, even though the person or agency to which dissemination of such information is proposed to be made may have been solely or partly responsible for its production.

(c) *Information Originating in Another Department or Agency:* Except as otherwise provided by section 102 of the National Security Act of July 26, 1947, c. 343, 61 Stat. 498, as amended, 50 U. S. C. sec. 403, classified defense information originating in another department or agency shall not be disseminated outside the receiving department or agency without the consent of the originating department or agency. Documents and material containing defense information which are classified Top Secret or Secret shall not be reproduced without the consent of the originating department or agency.

SECTION 8. TRANSMISSION

For transmission outside of a department or agency, classified defense material of the three categories originated under the provisions of this order shall be prepared and transmitted as follows:

(a) *Preparation for Transmission:* Such material shall be enclosed in opaque inner and outer covers. The inner cover shall be a sealed wrapper or envelope plainly marked with the assigned classification and address. The outer cover shall be sealed and addressed with no indication of the classification of its contents. A receipt form shall be attached to or enclosed in the inner cover, except that Confidential material shall require a receipt only if the sender deems it necessary. The receipt form shall identify the addressor, addressee, and the document, but shall contain no classified information. It shall be signed by the proper recipient and returned to the sender.

(b) *Transmitting Top Secret Material:* The transmission of Top Secret material shall be effected preferably by direct contact of officials concerned, or, alternatively, by specifically designated personnel, by State Department diplomatic pouch, by a messenger-courier system especially created for that purpose, or by electric means in encrypted form; or in the case of information transmitted by the Federal Bureau of Investigation, such means of transmission may be used as are currently approved by the Director, Federal Bureau of Investigation, unless express reservation to the contrary is made in exceptional cases by the originating agency.

(c) *Transmitting Secret Material:* Secret material shall be transmitted within the continental United States by one of the means established for Top Secret material, by an authorized courier, by United States registered mail, or by protected commercial express, air or surface. Secret material may be transmitted outside the continental limits of the United States by one of the means established for Top Secret material, by commanders or masters of vessels of United States registry, or by United States Post Office registered mail through Army, Navy, or Air Force postal facilities, provided that the material does not at any time pass out of United States Government control and does not pass through a foreign postal system. Secret material may, however, be transmitted between United States Government and/or Canadian Government installations in continental United States, Canada, and Alaska by United States and Canadian registered mail with registered mail receipt. In an emergency, Secret material may also be transmitted over military communications circuits in accordance with regulations promulgated for such purpose by the Secretary of Defense.

(d) *Transmitting Confidential Material:* Confidential defense material shall be transmitted within the United States by one of the means established for higher classifications, by registered mail, or by express or freight under such specific conditions as may be prescribed by the head of the department or agency concerned. Outside the continental United States, Confidential defense material shall be transmitted in the same manner as authorized for higher classifications.

(e) *Within an Agency:* Preparation of classified defense material for transmission, and transmission of it, within a department or agency shall be governed by regulations, issued by the head of the department or agency, insuring a degree of security equivalent to that outlined above for transmission outside a department or agency.

SECTION 9. DISPOSAL AND DESTRUCTION

Documentary record material made or received by a department or agency in connection with transaction of public business and preserved as evidence of the organization, functions, policies, operations, decisions, procedures or other activities of any department or agency of the Government, or because of the informational value of the data contained therein, may be destroyed only in accordance with the act of July 7, 1943, c. 192, 57 Stat. 380, as amended, 44 U. S. C. 366–380. Non-record classified material, consisting of extra copies and duplicates including shorthand notes, preliminary drafts, used carbon paper, and other material of similar temporary nature, may be destroyed, under procedures established by the head of the department or agency which meet the following requirements, as soon as it has served its purpose:

(a) *Methods of Destruction:* Classified defense material shall be destroyed by burning in the presence of an appropriate official or by other methods authorized by the head of an agency provided the resulting destruction is equally complete.

(b) *Records of Destruction:* Appropriate accountability records maintained in the department or agency shall reflect the destruction of classified defense material.

SECTION 10. ORIENTATION AND INSPECTION

To promote the basic purposes of this order, heads of those departments and agencies originating or handling classified defense information shall designate experienced persons to coordinate and supervise the activities applicable to their departments or agencies under this order. Persons so designated shall maintain active training and orientation programs for employees concerned with classified defense information to impress each such employee with his individual responsibility for exercising vigilance and care in complying with the provisions of this order. Such persons shall be authorized on behalf of the heads of the departments and agencies to establish adequate and active inspection programs to the end that the provisions of this order are administered effectively.

SECTION 11. INTERPRETATION OF REGULATIONS BY THE ATTORNEY GENERAL

The Attorney General, upon request of the head of a department or agency or his duly designated representative, shall personnally or through authorized representatives of the Department of Justice render an interpretation of these regulations in connection with any problems arising out of their administration.

SECTION 12. STATUTORY REQUIREMENTS

Nothing in this order shall be construed to authorize the dissemination, handling or transmission of classified information contrary to the provisions of any statute.

SECTION 13. "RESTRICTED DATA" AS DEFINED IN THE ATOMIC ENERGY ACT

Nothing in this order shall supersede any requirements made by or under the Atomic Energy Act of August 1, 1946, as amended. "Restricted Data" as defined by the said act shall be handled, protected, classified, downgraded, and declassified in conformity with the provisions of the Atomic Energy Act of 1946, as amended, and the regulations of the Atomic Energy Commission.

SECTION 14. COMBAT OPERATIONS

The provisions of this order with regard to dissemination, transmission, or safekeeping of classified defense information or material may be so modified in connection with combat or combat-related operations as the Secretary of Defense may by regulations prescribe.

SECTION 15. EXCEPTIONAL CASES

When, in an exceptional case, a person or agency not authorized to classify defense information originates information which is believed to require classification, such person or agency shall protect that information in the manner prescribed by this order for that category of classified defense information into which it is believed to fall, and shall transmit the information forthwith, under appropriate safeguards, to the department, agency, or person having both the authority to classify information and a direct official interest in the information (preferably, that department, agency, or person to which the information would be transmitted in the ordinary course of business), with a request that such department, agency, or person classify the information.

SECTION 16. REVIEW TO INSURE THAT INFORMATION IS NOT IMPROPERLY WITHHELD HEREUNDER

The President shall designate a member of his staff who shall receive, consider, and take action upon, suggestions or complaints from non-Governmental sources relating to the operation of this order.

SECTION 17. REVIEW TO INSURE SAFEGUARDING OF CLASSIFIED DEFENSE INFORMATION

The National Security Council shall conduct a continuing review of the implementation of this order to insure that classified defense information is properly safeguarded, in conformity herewith.

SECTION 18. REVIEW WITHIN DEPARTMENTS AND AGENCIES

The head of each department and agency shall designate a member or members of his staff who shall conduct a continuing review of the implementation of this order within the department or agency concerned to insure that no information is withheld hereunder which the people of the United States have a right to know, and to insure that classified defense information is properly safeguarded in conformity herewith.

SECTION 19. REVOCATION OF EXECUTIVE ORDER NO. 10290

Executive Order No. 10290 of September 24, 1951 is revoked as of the effective date of this order.

SECTION 20. EFFECTIVE DATE

This order shall become effective on December 15, 1953.

DWIGHT D. EISENHOWER.

THE WHITE HOUSE, *November 5, 1953.*

The CHAIRMAN. Proceed, Mr. Niederlehner, if you will.

Mr. NIEDERLEHNER. The standard which is prescribed by the President for us is the national security. The Executive order sets out basically three classifications in descending order of criticality of the information. Top Secret, Secret, and Confidential. It further prescribes the method of classification, the authority to apply the classification, the process of declassification, marking and identification, custody and safekeeping, accountability, and dissemination, including transmission—the manner in which these documents are passed from one authorized agency to another.

The declassification of material is also provided for within the Executive order. And this is one of the serious problems which confronts the Department of Defense at the present time.

We have had a special study performed by a committee which was known as the Coolidge committee, headed by Mr. Charles Coolidge, of Boston. And as a result of his studies a separate division was set up within the Department to study the process of declassification of documents to relieve us of the burden of a tremendous accumulation of material. That division is presently engaged in an effort to simplify the entire declassification process. And if possible establish a system of automatic declassification by cutoff dates, with minimum exceptions.

Until that directive actually goes into effect, the Executive order itself which provides for classification also provides systems of declassification. It encourages automatic changes on the basis of cutoff dates. It provides for systems of review so that the material may from time to time be declassified. It established further conditions; for example, upon removal of certain attachments to documents, there may be declassification; or upon the occurrence of a specific event, after which the material presumably has no further security value.

The difficulty with the present system, I think, is the requirement of the exercise of judgment with respect to the individual piece of

classified material which is in possession of the Government. And when the custodian is busy performing other duties, sometimes he doesn't have time to go back and review the activities of yesterday and attempt to declassify it.

To alleviate this situation, as I say, we are addressing ourselves to a system of automatic declassification on the theory that after the passage of a certain period of time this material will automatically have lost its security significance.

The CHAIRMAN. Do you agree that any new agency established should have access to classified data both ways—the Defense Department with the new agency, and the new agency with the Defense Department?

Mr. NIEDERLEHNER. The standard, Mr. Chairman—I would say this: That if the new agency is going to work in an area—and I understand this is the intention—which will apply the experience and accumulated wisdom of the Atomic Energy Commission on the one hand and the Department of Defense on the other, then in accordance with proper safeguards, it should, of course, be granted access to classified information.

The system of interworking between agencies, I think is quite smooth. There are established standards which apply across the board for clearance and for classification.

And the standard of access is first a clearance of the individual, to determine his own reliability, and secondly a need to know. And I think in the case of an agency which is operating in the field of the new space agency, it certainly will have a need to know all the relevant material already existing in the Government with respect to the activities in which it is going to engage.

Mr. NATCHER. Mr. Feldman.

Mr. FELDMAN. As you know we will have to consider a security provision in the new proposal. That is primarily why we asked you to come here in this connection. And as you just stated, there will be a close working relationship between the Pentagon and a new civilian agency, if and when it is set up.

Now, can you explain briefly what standards are used in connection with determining when materials shall be declassified?

Mr. NIEDERLEHNER. Well, I would say there are no specific standards applied to declassification in and of itself. The process is somewhat the reverse of the classification process. When you find that those considerations which required the original classification no longer obtain, then the material should be declassified.

Would you like to have me read into the record the basis for classification under the present Executive Order 10501 which applies throughout the Government except for the specific provisions of the Atomic Energy Act?

Mr. FELDMAN. Yes.

Mr. NIEDERLEHNER. Section 1, which sets these general standards provides that:

> Official information which requires protection in the interests of national defense shall be limited to three categories of classification which in descending order of importance shall carry one of the following designations: Top Secret, Secret, or Confidential. No other designation shall be used to classify defense information including military information as requiring protection in the interests of national defense except as expressly provided by statute. These categories are defined as follows:

"(a) Top Secret: Except as may be expressly provided by statute, the use of the classification Top Secret shall be authorized by appropriate authority only for defense information or material which requires the highest degree of protection. The Top Secret classification shall be applied only to that information or material the defense aspect of which is paramount, and the unauthorized disclosure of which could result in exceptionally grave damage to the Nation such as leading to a definite break in diplomatic relations affecting the defense of the United States, an armed attack against the United States or its allies, a war, or the compromise of military defense plans or intelligence operations, or scientific or technological developments vital to the national defense."

The next category is "Secret":

Except as may be expressly provided by statute the use of the classification Secret shall be authorized by appropriate authority only for defense information or material the unauthorized disclosure of which could result in serious damage to the Nation, such as by jeopardizing the international relations of the United States, endangering the effectiveness of a program or policy of vital importance to the national defense, or compromising important military or defense plans, scientific or technological developments important to national defense, or information revealing important intelligence operations.

And the third and last category is "Confidential":

Except as may be expressly provided by statute, the use of the classification Confidential shall be authorized by appropriate authority only for defense information or material the unauthorized disclosure of which could be prejudicial to the defense interests of the Nation.

Now, basically the standard is the defense interests of the Nation. There is somewhat of an elaboration in each of these three categories, and the directive which carries out this Executive order within the Department of Defense elaborates these just a bit further by giving examples.

Mr. FELDMAN. The directives, of course, would describe in greater detail what does and what doesn't come under each of these categories. Isn't that right? The directive is a regulation which is promulgated pursuant to the Executive order?

Mr. NIEDERLEHNER. This topic is covered in section IV of the Directive called "Classification categories."

Mr. FELDMAN. Now, in reading from some of the testimony before the Moss committee, particularly some of the testimony of General David, he indicated that his unit might classify 200,000 documents in 1 year and subsequently he would only have time to go over, say, 20,000 of those documents to determine whether they should be declassified in the following year.

Is there some rule or regulation which holds that the person or unit making the classification has to also make the declassification?

Mr. NIEDERLEHNER. There is not a specific requirement for going back to the exact unit or the exact person. This interpretation of the Executive order has had to be considered very carefully in relation to this proposed new procedure for automatic declassification on a time basis.

If you are going to put into effect such an automatic system, of course, it would be totally defeated by reference back to the exact individual or unit which imposed the original classification.

Now, the Executive order provides in section 4 (f) for downgrading—if the recipient of classified material believes it has been classified too highly he may make a request to the reviewing official who may downgrade or declassify the material after obtaining the consent of the appropriate classification authority.

Now, we are applying or proposing to apply this general provision of the Executive order on a very general basis.

We will provide through a Secretary of Defense order for a procedure of automatic declassification, and for the authorization at a fairly low level of delegation for the actual act of declassification, or for the review of the material which is declassified if it does not fall within certain exceptions.

Mr. FELDMAN. Do you have a copy of the Coolidge report available?

Mr. NIEDERLEHNER. I don't have it with me but I can furnish that for the record.

(Following is a summary of the recommendations of the Coolidge committee on classified information. They are taken from the "Department of Defense Implementation of the Recommendations of the Coolidge Committee," which contains the recommendations of the committee, plus their implementation by the Department of Defense:)

Recommendation No 1—Make a determined attack on overclassification, spearheaded by the responsible heads within the Department of Defense, from the Secretary of Defense down.

Recommendation No. 2a.—Supply guides to overcome the generality of classification criteria.

Recommendation No. 2b.—Broaden Recommendation No. 1 by requiring that all superiors reject overclassified material received from subordinates.

Recommendation No. 2c.—Cut down the number who are authorized to classify information as Top Secret and to receive copies of Top Secret papers.

Recommendation No. 2d.—Require that each program or order susceptible of such treatment contain a special paragraph dealing with information security.

Recommendation No. 2e.—Make wholly clear that the classification system is not to be used to protect information not affecting the national security.

Recommendation No. 2f.—Cease attempts to classify information which cannot be held secret.

Recommendation No. 2g—Improve procedures for releasing information as to the existence and general nature of differences of opinion between the several Services to permit authorized representatives to express Service views, without disparaging their sister Services, and without, of course, disclosing information which is classified for reasons other than differences in military concept between the Services

Recommendation No. 2h—Avoid changing scope of classified information to reflect temporary changes in emphasis in our foreign policy.

Recommendation No. 2i.—Establish within the Office of the Secretary of Defense an official who will be responsible for establishing and monitoring an active declassification program.

Recommendation No 3a—Designate one official in the Office of the Secretary of Defense as responsible for seeing that investigations of "leaks" are initiated with utmost promptness on their occurrence and are vigorously pursued.

Recommendation No. 3b.—Within each military department start investigating machinery going instantly upon occurrence of an unauthorized disclosure.

Recommendation No. 3c—Convene courts of inquiry of triservice composition in case of a serious "leak."

Recommendation No 3d.—In case of a "leak" appearing in the press which obviously gravely damages the security of the Nation, and where the source of the "leak" cannot be identified, summons the author to testify in a grand jury investigation in order to discover the source.

Recommendation No 4a—Take prompt and stern disciplinary action when the source of a "leak" is identified.

Recommendation No. 4b—Take prompt and stern disciplinary action when an individual has not accepted a decision reached by the Secretary of Defense or higher authority.

Recommendation No. 4c.—Hold commanders responsible for security derelictions within their commands.

Recommendation No. 5a.—Fix responsibility for protecting administrative matters

Recommendation No. 5b.—Amended Department of Defense Directive 5200.6 to include protection for information relating to advice on official matters and

compel use of "For Official Use Only" stamp on all future documents entitled to protection under that directive.

Recommendation No. 5c.—Initiate a program of indoctrination among all personnel of the Department of Defense to instill a proper regard for safeguarding of all information protected by Department of Defense Directive 5200.6.

Recommendation No. 5d.—Take appropriate and prompt investigative and disciplinary action in cases of unauthorized disclosure of information on these administrative matters.

Recommendation No. 6a.—Take steps to develop a better understanding in certain parts of industry of the hazards to national security resulting from disclosure of certain technical classified information.

Recommendation No. 6b.—Take vigorous steps to stop leaks to trade and technical journals.

Recommendation No. 7.—Exercise care in the publishing of reports of proceedings before congressional committees to eliminate sensitive technical data and classified operational concepts.

Recommendation No. 8a.—Arrange interviews with Department of Defense members through the Office of Public Information, with a representative sitting in if requested.

Recommendation No. 8b.—Release a forceful statement to the press outlining the differences between ordinary peace and the present situation from the point of view of information security.

Recommendation No. 8c.—Give reasons for classification whenever possible when requests for information are denied.

Recommendation No. 9.—Concentrate implementation of these recommendations on the Washington area.

CHARLES A. COOLIDGE, *Chairman.*
Adm. WILLIAM M. FECHTELER, USN (Ret.)
Gen. JOHN E. HULL, USA (Ret.)
Gen. GERALD C. THOMAS, USMC (Ret.)
Lt. Gen. IDWAL H. EDWARDS, USAF (Ret.)

NOVEMBER 8, 1956.

Mr. FELDMAN. Now, you spoke of an automatic declassification by a certain date. What is that date? How does that work precisely in practice? And what is the date, if you can give it to us?

Mr. NIEDERLEHNER. We have under discussion at the present time, a period subsequent to World War II. It is hoped that we will be able to settle upon a period in the total military history, you might say, of the United States in which there was a very abrupt change of technology so that material which existed before that time does not retain, with certain exceptions, significant security aspects.

And what we have in mind at the present time is a date subsequent to World War II.

Mr. FELDMAN. Well, that would still include a great many years. In other words, I want to get to the construction of the matter if I can, from the point of view of a provision in a law which this committee might submit to Congress.

And that is this. I have read in the transcript of testimony before the Moss committee that a situation could exist where 200,000 documents were classified. Because of the lack of time, only 20,000 of those could be reviewed for declassification in subsequent years. As a consequence you have a tremendous accumulation.

So that material which could and should be declassified is never reached because of the piling up of previous years' classification. This continues to a point where it becomes humanly or physically impossible to do the kind of declassification job essential in order to permit the information to become available to the public.

Now, this becomes increasingly important as the result of testimony before this committee by scientists who claim that in order to be

helpful, they must have available as much scientific or technical information as possible.

And certainly, if the material is declassified, it should be made available to them.

Now, using that as a background, could you give us, or could you tell us, what, if anything, the Defense Department is doing to alleviate that situation?

Mr. NIEDERLEHNER. Well, I would like to cover that in two points, Mr Feldman. First, the access to information on the part of scientists or members of the overall industrial community is not blocked or hampered by the fact that the material is classified.

Mr. FELDMAN. Could you tell us why?

Mr. NIEDERLEHNER. Individuals outside of the Government, for example, may be granted access to classified information whenever this is in the interest of national security. And there are three distinct programs within the Department of Defense at the present time to grant such access. First is the program with respect to the actual Government employee, the civil servant; secondly, the military individual who requires access to information; and the third program is the dissemination of information to private industry.

The vast bulk of the scientific and manufacturing work which is performed for the Department of Defense is performed by private industry.

Colonel Rubenstein reminds me that there are approximately 22,000 plants and 3 million people who may be involved in work which is actually classified, so that the material is not generally disseminated to the public, but it is made available to the individual whose performance of duty requires that he know this particular information.

Now, the second portion of your question, I think, relates to the next step which would be actually to declassify the material and put it into the public domain. We have, of course—I have mentioned this problem of the general declassification. And the program does go back, as you say, to 1945, which is a few years ago.

But it is a very practical first step against a vast bulk of accumulation.

Now, the fact that this automatic step is attempted with respect to that vast bulk does not mean that there aren't currently other activities which must be undertaken with respect to not only the accumulations since 1945 but the material which may be receiving a classification today.

Now, the Executive order provides that formal procedures shall be established to provide specific means for prompt review of classified material and its declassification or downgrading in order to preserve the effectiveness and integrity of the classification system and to eliminate accumulation of classified material which no longer requires protection in the defense interests. The big point there is that the effectiveness of the classification system itself depends in large measure upon the reduction of the number of documents which receive the classification.

So that you can maintain a healthy respect for a few documents and really preserve the absolute secrets which require preservation in the national interest.

Now, it goes on to provide the following special rules shall be observed with respect to changes of classification of defense material.

And then there are a number of specific impositions—the automatic changes, the provisions that after a certain date the document is not classified, upon removal of a certain attachment it is not classified, the provision that upon a certain occurrence, upon the launching of a missile or the delivery, shall we say, of a new aircraft for general operational use, certain classification is automatically removed.

In addition to this, as I say, there is the overall requirement throughout the structure for a periodic review.

There are very stringent requirements with respect to the highest classification, top secret, because there is a requirement for a continuous inventory. And there is an automatic incentive, you might say, with respect to the custodian to relieve himself of the burden of this material because of the restrictions upon its use, its storage, and its continued classification. So that the individual, I think, who has the authority to classify really has some countervailing forces upon him. Because when he classifies it, he immediately incurs for himself an administrative burden in handling and disseminating that piece of paper.

And, as soon as he can declassify it, he finds it is much easier for him to deal with it.

Colonel Rubenstein invites my attention to the document which is known as the Armed Forces Industrial Security Regulation.

And in view of the fact that a great volume of this material which relates to technological matters must be constantly in the possession of American industry, there are specific requirements for its classification, its storage, and its use, and its dissemination only to cleared personnel.

There is a specific requirement here for a review and report every 6 months to the contracting officer with respect to the material which the particular plant has in its possession.

I would point out that the plant itself, the private industry, has an administrative burden in dealing with this material, and, therefore, it has an incentive to have it declassified, and to have the material downgraded for ease of handling or for actual disposition or destruction.

Mr. FELDMAN. Now, you spoke of the Coolidge recommendations and the implementation of the Coolidge recommendations with the directive. Has that taken effect as yet?

Mr. NIEDERLEHNER. The principal recommendation in this area related to this vast accumulation of material. And in accordance with this recommendation there was established a separate unit within the Department of Defense, the sole responsibility of which is to seek ways and means of downgrading and declassifying material and having it either disposed of, made available for general dissemination, or as a very minimum to relieve the custodian of this burden of preservation.

There is a division within the Department of Defense under the Assistant Secretary for Public Information which is headed by retired Vice Admiral Hoskins. They are working on the automatic procedure. But also they have a very close working relationship with the military departments in an effort to see that all of these previous devices which are set forth in the Executive order are carried out.

They are confident that they are producing a substantial result even aside from the automatic approach to declassification. And they have been requiring reports on volume of declassification, number of documents declassified, number of documents destroyed, and so forth.

And they are making, as I say, substantial progress outside of the overall approach.

Mr. FELDMAN. Has there been any report from this division on the amount of classification or declassification of progress reports, so to speak?

Mr. NIEDERLEHNER. I think there has been one; yes. Approximately a month ago.

(The above-mentioned report is as follows:)

(The Semiannual Report of the Office of Declassification Policy, July 1–December 31, 1957.)

SEMIANNUAL REPORT OF THE OFFICE OF DECLASSIFICATION POLICY, OASD (PA)
July 1 to December 31, 1957

I. INTRODUCTION

On August 13, 1956, the Secretary of Defense appointed the Committee on Classified Information, with Mr. Charles A. Coolidge as chairman, to study the problem of unauthorized disclosure of classified information, and to suggest means of correcting this threat to national security.

Its report became public November 8, 1956. In addition to a series of proposals for greater protection of properly classified information, the Committee pointed out that overclassification had "reached serious proportions." It recommended a "determined attack" against this practice. Further, it suggested establishment of an office which would be responsible for creating, directing and monitoring an active declassification program. Such a program, the Committee said, should help more fully to carry out declassification provisions of Executive Order 10501 (November 5, 1953), which had "not been working satisfactorily."

Accordingly, on March 22, 1957, Department of Defense Directive 5105.12 authorized the Office of Declassification Policy, and defined its responsibilities within the Office of Assistant Secretary of Defense for Public Affairs.

II. ORGANIZATION OF THE OFFICE

On July 1, 1957, Vice Admiral John M. Hoskins, USN (Retired), was appointed Director of this Office Following assignment of key members to his staff, Admiral Hoskins completed an organization which consisted of the Directorate, an Executive Secretary, a Military Advisory Staff, a Special Assistant for Technical Programs, A Current Programs Division, and a Future Programs Division. (See Exhibit 1 of the Appendix for organization chart.)

By designation of the Assistant Secretary of Defense for Public Affairs, a Declassification Policy Committee was named to include principal military security policy officers in the military departments. This committee, of which Admiral Hoskins is Chairman, consists of Major General Joseph F Carroll, Deputy Inspector General for Security, U. S Air Force; Brigadier General Royal Reynolds, Jr., Director of Plans, Programs and Security in the Office of the Assistant Chief of Staff, Intelligence, U. S Army; and Rear Admiral Vernon L. Lowrance, Deputy Director of Naval Intelligence for Security, U. S Navy. This committee has held a total of thirteen formal meetings to consider problems in connection with the work of the Office.

In addition, Mr. Paul R. Leach, retired Washington newspaperman, was employed as a part time consultant, representing the viewpoint of public information media. As the office penetrates deeper into the area of complex scientific and technical information, it may be advisable to employ a competent scientist as a consultant. At the present time, the Office of Declassification Policy is depending on members of the Office of the Assistant Secretary of Defense (Research and Engineering) and some of the members of their Technical Advisory Panel for informal advice on declassification of scientific data.

III. OVERALL PROBLEM OF ESTABLISHING A DECLASSIFICATION PROGRAM

At one of the early meetings of the Declassification Policy Committee, it was recommended that the Chairman appoint task forces to study the many problems involved, and report to the Committee on courses of action that would lead to the establishment of a coordinated Department-wide program for the downgrading and declassification of classified information.

Further, it was recommended that one phase of the study should be addressed to the possibility of action being taken by the Secretary of Defense to accomplish two things:

A. To declassify by blanket order information contained in classified documents originated prior to some specified date; and

B. To establish a requirement effecting automatic downgrading of information from the higher categories on a basis of passage of time.

In each case, it was suggested that excepted types of documents and information could be designated in the interest of security.

IV. CURRENT ACTION OF THE OFFICE OF DECLASSIFICATION POLICY AND TASK FORCES

To carry out expeditiously the recommendations of the Declassification Policy Committee, the Chairman appointed five interrelated task forces with specific assignments. In addition, members of his staff were directed to undertake studies of various other segments of the overall downgrading and declassification problem. (See Exhibit 2 for Plan of Operation.) The following progress has been made:

Blanket declassification

Five months of detailed discussions and investigations in conjunction with the military departments and other agencies of the Department of Defense have been conducted by Task Force "A". This has led to the preparation of a proposed directive, which, if approved, will cancel the Defense Department's classification on certain documents which were originated prior to January 1, 1946, and downgrade to SECRET most TOP SECRET documents originated prior to that date which are not declassified by the directive. The proposed directive contains certain excepted categories which have been determined at this time to fall within the specified provisions for safeguarding national security of Executive Order 10501.

Assuming passage of time as an acceptable basis for consideration as to whether documents or information need be kept under protection, the Office of Declassification Policy will continue its study and analysis of those excepted categories so as to narrow progressively the areas which now prevent information from being removed from the classification system.

Task Force "A", in addition to holding a total of six formal meetings, has engaged in countless special conferences with members of the various military departments and other agencies.

It should be noted that in all declassification and downgrading processes, competent review on request will be necessary, initially, to ensure that both security and the public interest are observed.

Automatic Downgrading

Task Force "B" is investigating and studying the problems involved in automatic downgrading of information from the higher categories on the basis of the passage of time. Study to date reveals that although Executive Order 10501 provides that where possible a date for automatic declassification be set at the time of classification, this device is not widely used. This is primarily because of reluctance of people charged with classifying authority to attempt to predict the future. An evaluation of the studies made during recent months by Task Force "B" has led to the conclusion that the technique of automatic declassification by date could and should be used much more widely. Consequently, a directive draft is now being prepared to effect automatic downgrading of information from higher categories on the basis of the passage of time. This problem is scheduled for presentation to the Declassification Policy Committee at an early date.

Because of the complexity of the problem, many separate investigations had to be made by individual members of Task Force "B"; hence, only three formal meetings have been held.

Marking of Declassified and Downgraded Papers

Early in July 1957, the Chairman of the Declassification Policy Committee appointed Task Force "C" to make a study of present requirements for marking of downgraded and declassified documents, and to investigate methods which would reduce this burden.

Following an extensive investigation by Task Force "C," its findings were turned over to Task Force "A," engaged in the preparation of the blanket order directive described above. Simple directions for marking were provided in the draft directive, which were considered adequate by the advisers to the Joint Staff of the Joint Chiefs of Staff with whom the draft directive was coordinated.

Task Force "C" held six formal meetings, and, in addition, investigated various kinds of marking devises. On November 17, 1957, the Task Force, having completed its assignment, was discharged.

Classified technical material at universities

A serious declassification problem was brought to the attention of the Office as a result of an exchange of correspondence between Dr. Frederick L. Hovde, President of Purdue University, and Dr. James H. Doolittle, Chairman, Air Force Scientific Advisory Board. This concerns the disposition of document collections pertaining to basic military research projects conducted by the University. On August 8, 1957, the Chairman of the Declassification Policy Committee appointed Task Force "D" to study the problem and to determine the feasibility of improving the policy with respect to classified material in the custody of educational and research institutions.

Task Force "D" examined records available at the Washington level containing valuable information bearing on the problem. Further, it investigated the extent to which the work of the Armed Services Technical Information Agency (ASTIA) represented a source of assistance affecting university records collections, and the nature of the depository library system established at universities by the Atomic Energy Commission.

Through the efforts of Task Force "D," the Purdue University records collection is now receiving declassification review on an experimental basis by the Air Force Office of Scientific Research. It was felt, however, that a substantial portion of these documents might be subject to the proposed January 1, 1946, directive, while the balance will have to be cleared by regular review procedures. It is hoped that the pilot attention given to the Purdue University case will serve to identify any further problems and provide a guide to future action with respect to classified collections in the custody of other educational and research institutions having similar problems.

Further, the Office of Declassification Policy now is evaluating the feasibility of a plan, resulting from investigations of Task Force "D," to sponsor action by other groups in the Office of the Secretary of Defense to establish a university depository library system.

Task Force "D" held a total of four formal meetings and had numerous informal discussions with representatives of the military services, the Office of the Secretary of Defense, the Atomic Energy Commission, and visited the Armed Services Technical Information Agency center at Dayton, Ohio.

Indexing of Classified Material

In order to recommend practical means of assuring the review and appropriate downgrading or declassification of records at the time they are processed for retirement, the Declassification Policy Committee recommended separate study. On September 5, 1957, the Chairman appointed Task Force "E" to study creation of a subject index and/or catalog of classified documents.

To explore fully the problem involved in setting specific requirements for action in this area, Task Force "E" included members of the records management offices of the three military departments. Preliminary investigation by the Task Force established two basic problems in connection with its assignment:

1. To study the present record index systems used by the military services as to: adequacy in document identification for access; provision for accounting and screening of classified documents; and the use which might be adopted for declassification actions.
2. Investigation toward finding some practical means of assuring review for downgrading or declassification of documents at the time they are processed for retirement.

Task Force "E", after detailed investigation, determined that the maintenance of catalogs of individual random declassifications would serve no purpose, and that declassification on a broad category basis by dates or by subject matter could be maintained centrally and published periodically for use by interested parties.

In the course of its work, Task Force "E" uncovered two apparently forgotten books, published at the end of World War II by the National Archives at a cost of $230,000. These books identify the Department of Defense records of World War II, give a brief description of what they contain, where they are located, and in what amounts It was concluded that, although these books did not specifically meet the needs of this office, they did provide ample guides to help in future work of this office. Also, the Task Force determined that a more detailed index would be prohibitive in light of the expense incurred in compiling even such a broad list as that contained in the above-mentioned volumes.

With respect to the second problem, the Task Force concluded that due to the necessary variations in records management procedures required by the differences in missions and organization of the respective military departments, it would not be desirable or practicable to prepare a single overall directive.

General conclusions of Task Force "E" in this respect are: (1) Greater emphasis by the Office of the Secretary of Defense is needed in order to insure not only review of documents for downgrading prior to retirement, but, also, constant review at the office of origin; (2) authority from the Office of the Secretary of Defense is required to relieve offices of origin of the requirement for individual notification of downgrading action at the time of retirement; (3) overall procedures governing all departments should not be established at the level of the Office of the Secretary of Defense, because costs of consolidating the widely different filing and retiring methods could not be justified.

Following the report of Task Force "E," the Declassification Policy Committee recommended, and the Chairman directed, that certain findings and recommendations with respect to automatic downgrading be turned over to the Task Force charged with responsibility in that area.

Task Force "E" held fourteen formal meetings, and visited the National Archives and other depositories to determine the extent of the problems involved.

V. REPORTING REQUIREMENTS

In accordance with Directive No. 5105.12, the Office of Declassification Policy is responsible for monitoring an active downgrading and declassification program. To perform this function, it is necessary to establish reporting requirements in the military departments and other agencies of the Department of Defense in order to assess adequately the status, progress, efficiency, and effectiveness of the program.

Recently, the staff has been testing out various types of reports in order to establish standards that would be realistic and not impose too great a burden on the military departments, yet would provide the office with sufficient data to determine trends and evaluate the effectiveness of the declassification program. A set of reporting standards now is being developed.

VI. DECLASSIFICATION EDUCATION PROGRAM

Staff studies of the problems involving the declassification and downgrading of documents to which security classification had been assigned suggested that there should be a more realistic initial appraisal of the need for protecting defense information in accordance with Executive Order 10501. It was realized that the amount of classified information could be reduced substantially if means could be developed to overcome the inclination, of those charged with classifying authority, to overclassify, or even to classify, when national security would not be impaired.

It appeared obvious that real achievement in this area would depend, to a large extent, on how well informed the classifiers are with respect to precisely what defense information should be protected in accordance with classification guidelines established by Department of Defense Directive No. 5200.1. It was determined that effective emphasis might be achieved throughout the Department, particularly among officers of the military, if greater attention and/or additional courses in classification and the dangers of overclassification were provided in the several Service schools.

A draft of a proposed memorandum to the Secretaries of the three military departments now is undergoing revision. This will request that serious attention be given to developing programs of instruction in classification policy and techniques in the Service schools. It is hoped that such courses of instruction will lead to more realistic classification and less overclassification.

As a result of discussions at several Declassification Policy Committee meetings, the Navy Department already has taken active steps in anticipation of the memorandum by issuing instruction to 6 Service schools and 58 reserve schools, stressing the dangers of overclassification and emphasizing the needs and means for declassification. (See Exhibit 3 for Instruction.)

An article is scheduled for publication in the Navy's quarterly training bulletin, stressing the evils of overclassification. (See Exhibit 4 for copy of article.) The Navy's new security manual, now being printed, has been carefully edited to eliminate any looseness that would precipitate overclassification and to emphasize declassification. This revised edition, for correspondence courses and officer promotion examinations, incorporates instruction and questions on overclassification and declassification.

VII. SPECIAL PROJECTS UNDER JOINT STUDY WITH MP&R

Employing specific talents and particular experience of certain members of the staff, studies of two problem areas in the technical and industrial fields were sponsored by the Office of Declassification Policy. They now are being worked on with the staff of the Office of the Assistant Secretary of Defense (Manpower, Personnel, and Reserve). If these two projects succeed, a policy will follow for uniform phased downgrading and declassification of specific technical subjects. In addition, a substantial dollar savings in the industrial field will result. Outlines of these projects and the progress made to date follows:

A. Phased downgrading and declassification plan

Lack of uniformity in criteria for classifying and declassifying exists throughout the technical fields due primarily to emphasis being placed on physical protection for classified documents and material. If any considerable part of this matter is overclassified, the cost to the Government for guarding, packaging, and shipping is far in excess of what would be required if security considerations were realistically applied.

Early in November 1957, the Office of Security Policy (MP & R) sponsored an ad hoc committee to consider the desirability of adopting the U. S. Navy Bureau of Aeronautics' concept of a classification guide and phased downgrading system. Cognizant security personnel of the military services and a member of this staff served on this committee. After two meetings, it was unanimously agreed that the principle involved appeared sound and would be desirable if it could be applied "across the board." To this end, a working group was set up to develop the concept. The initial meeting of this group was held the first week of December 1957. The group has continued to meet once a week for a three-hour session. Progress has been made in the formulation of criteria and details necessary for a combined system. A member of this staff also is on this working group.

B. Accountability for destruction of contractor-generated confidential material

Industrial companies in the process of manufacturing classified equipment under Department of Defense contracts usually generate thousands, and even sometimes millions, of classified documents, such as inter or intraplant orders and memoranda, partial or complete reproductions of classified drawings and specifications, status or progress reports.

Under the regulations of the May, 1955, Industrial Security Manual, the contractor was required to record the destruction of all Top Secret and Secret information, and only such Confidential information as was furnished by the Government However, under the Manual as revised in September, 1956, paragraphs 8 and 14f require that an appropriate recording of Confidential information destroyed shall be maintained by the contractor for a period of ten years. Under this new requirement, the contractor has three alternatives, as follows:

1. To return millions of Confidential documents to the Government for storage, which would place a tremendous and costly burden on Government storage facilities and personnel;
2. To make the required appropriate record of each document destroyed, which would require about 4.5 man-hours per 1,000 documents, resulting in exceptionally large costs for each contractor, which would ultimately be charged against the cost of those or other contracts; or
3. To retain tons of old and largely useless Confidential files and provide the necessary storage space and safeguards, which, likewise, would have a high cost factor that the contractor would have to charge against contract costs.

However, the definition of what constitutes an appropriate recording for the destruction of contractor-generated Confidential information is subject to wide differences of interpretation. For example, many legal departments of reputable companies interpret an appropriate record to require full accountability. The cost of such accountability of Confidential matter by industry is estimated to be in the order of hundreds of millions of dollars per year, an even greater amount than the cost of retaining these old documents.

The extent of this problem, and its importance to industry and the Government, was brought to the attention of the Office of Declassification Policy by a member of the staff. An informal conference was held with several members of industry to determine if this Office could take any action by means of declassification techniques. It was decided first to enlist the support of the Office of the Assistant Secretary of Defense (MP&R) since the Industrial Security Manual is the responsibility of that Office. A meeting was held with members of the staff

of that Office, with the result that an immediate study of the problem was undertaken.

This Office was notified that new and corrective language is being prepared as an amendment to the Industrial Security Manual, which it is hoped, will eliminate this condition. This Office realizes that this proposal represents one of the most forward steps in our declassification program with respect to industry, and intends to follow its progress to assure a successful conclusion, either in conjunction with MP&R or by declassification means.

VIII. DIRECT AND INDIRECT RESULTS OF OFFICE OF DECLASSIFICATION POLICY ACTIONS

The Director has been greatly encouraged by both the direct and indirect results of the work of his Policy Committee, the five Task Forces and his staff. Although, in recent years, there has been an established policy in the military departments requiring review of classified matter for possible downgrading and/or declassification, there was little evidence of that policy being vigorously pursued, according to the Coolidge Committee report. If the military departments had been able to observe this policy over the last ten or fifteen years, there would not now be the enormous backlog of classified records and files unnecessarily accumulated in the various storage spaces, warehouses and depositories, that report stated.

It is evident at this time that the creation of this Office has stimulated concern throughout the Defense establishment of the dangers of overclassification, the necessity for a more realistic initial appraisal of the need for protecting defense information by classification, and the desirability of effective downgrading and declassification programs so as to avoid the building up of backlogs in the future.

Some of the direct actions on the part of the military departments are listed below:

A. U. S. Army actions

In September, 1957, the Army initiated action to revise its Military Security Manual AR 380–5, which will improve security, the administration of documents, the release of information to the public, and its provisions for declassification.

The two most import revisions which concern the Army's declassification program are:

1. Review for regrading with respect to responsibility. "In order to preserve the effectiveness and integrity of the classification system and to eliminate accumulation of classified material which no longer requires protection in the interests of national defense, every commander will keep under constant review all classified information in his custody or of primary interest to him. He will initiate action toward downgrading or declassifying it as conditions warrant. He also will designate persons (normally Security Control Officers) * * * to be responsible for continuing review and downgrading or declassifying of classified material originated within his headquarters and to act on requests for such review."
2. Downgrading or Declassification. "Top Secret and Secret material originating within the Army Establishment will be regraded Secret and Confidential respectively three years from the date of origin unless the originator or higher authority has: (1) authorized earlier downgrading by establishing a specific date or event for such downgrading, or (2) renewed the original classification by notification to all recipients prior to expiration of three years from the date of origin. Material for which the original classification has been extended by action in accordance with * * * above, will be subject to the same action three years from the date of the extension."

Further, the Army has issued two promotional items concerning downgrading and declassification, which have been distributed to all locations. (See Exhibits 5 and 6.) Exhibit 5 is a security classification guide, which now also is being distributed by the Security Services Division of the Office of the Secretary of Defense. The Navy and the Air Force will be urged, also, to adopt this promotion device through the Declassification Policy Committee.

The Army has taken steps to reduce drastically the number of individuals who are authorized to assign the classification of Top Secret to defense information. A conservative estimate indicated that approximately 1,600 individuals in the Department of the Army previously had authority to originate Top Secret material. Changes now being instituted indicate that the number of individuals will be limited to 46, and they will not have authority to delegate this responsibility.

Likewise, the authority to classify material Secret and Confidential will be curtailed to the maximum extent possible consistent with efficient operations.

Since July 1957, more than 90 news items were released to the public, all of which contained references to data which had to be declassified before the announcements could be made. Also, the various branches of the Army are reviewing over 1,300 reports annually with a view to declassification and ultimate publication in scientific and technical journals.

B. U. S. Navy and Marine Corps actions

The Chief of Naval Operations has circulated a draft of a proposed OP NAV Instruction entitled, "Declassification and Downgrading Program." This instruction grew out of the Navy's anticipation of a reporting requirement which would be forthcoming from the Office of Declassification Policy. The first staffing draft of this instruction was originated on July 25, 1957. The purpose of the instruction, in addition to a request for comments on an attached reporting form, was to emphasize the importance of the downgrading and declassification in the Navy, and to direct effective implementation. Included in this draft instruction are these reasons for the need of an active declassification program:

1. High cost in time, money, and personnel required for controlled handling, secure transmission, executing endless receipts, special security storage equipment, and reoccurring inventories.
2. Jeopardizing careers of personnel from security violations involving improperly classified information.
3. Poor public relations resulting from adverse criticism concerning vast volumes of classified records. Several methods of control of classification are mentioned, such as automatic downgrading or declassification after a given date, or upon a certain event, and controlling original classification. Also, a requirement is proposed for periodic inspections.

Authority to classify material in the Department of the Navy was delegated to approximately 2,890 persons prior to July 8, 1957. With the promulgation of the revised Navy Security Manual, original authority to assign Top Secret classification will specifically designate only 181 persons by title of office. This will result in about 50 persons having original classification authority for approximately 90% of all Top Secret Naval documents. Authority to assign Secret and Confidential classifications will be proportionally reduced.

Since June, 1957, the Navy has released 116 news items to the public which required certain downgrading and declassification action before they could be released. In addition, for use in Naval History, 250 photographs and 50 documents were declassified by the Security Review of the Navy.

Marine Corps actions

The U. S. Marine Corps has instituted an active declassification program under Headquarters Order No. 5511.7, dated 1 November 1957 (See Exhibit 7 for copy of Order), which requires that representatives from each Division and Department report on specific days to the central files for the purpose of review and marking of classified documents.

Since promulgation of this Order, all classified Marine Corps Headquarters' documents which were originated during 1955 have been reviewed with the following results:

Documents processed	2,938
Documents retaining original classification	1,717
Documents downgraded	219
Documents declassified	1,002

A schedule is anticipated to enable review of two past year documents during each coming year until all old records have been processed.

It is interesting to note that of the 1,002 documents which were declassified, there are still 800 which require that recipients of copies be notified. Personnel limitations and time involved in tracing through all the holders has caused the backlog. To overcome this problem, the Marine Corps bulletin now carries a list of declassifications by subject, serial number and recipients.

In addition, specific changes in "Procedures for Reclassification and Declassification" now are being incorporated in the revised version of the Marine Corps Security Manual. (See Exhibit 8 for a copy of these changes.)

C. U. S. Air Force actions

Although the Air Force basic security manual, AFR 205-1, was prepared shortly before the Office of Declassification Policy was established, its provisions with respect to emphasis on downgrading and declassification are still timely and

effective. However, these changes, which bear on the subject, recently have been transmitted to the field units:

1. Specific designation of individuals within the Air Force authorized to assign security classification. It substantially reduces the number of officials authorized to classify Top Secret and Secret.
2. Designation of an official, authorized to classify, as a point of contact for all classification and declassification actions within a headquarters or an office.
3. Outlining of action which is required when classified information is approved for declassification and public release.

The Air Force has carefully reviewed its requirements as to which officials, and how many, should be authorized to assign security classification. With respect to Top Secret and Secret authority, a revision of AFR 205-1, as noted above, has been completed. A previous report from the Air Force indicated that this revision would substantially reduce the number of persons having original classification authority. Indications were that the number would be limited to approximately 50 in the Departmental Headquarters.

During the months of November and December 1957, the Air Force released some 40 news items to the public which were of a technical or semitechnical nature. All of these releases contained information which required certain downgrading and declassification action before they could be released to the public.

VIII. NEW AND FUTURE PROJECTS, THE FEASIBILITY OF WHICH ARE UNDER STUDY BY THIS OFFICE

A. *Future automatic declassifications by specified time*

It became apparent to the staff that there was a need for a type of directive, or directives, that would establish a blanket time limit for future automatic declassification. Two major areas were considered:

1. Automatic declassification of everything, with certain excepted categories, after ten years unless reviewed and redated; and
2. Automatic declassification of all scientific and technical information, with a minimum of excepted categories, after ten years unless reviewed and redated.

Since it was felt that more rapid progress could be made in item 2 above, the staff has vigorously applied itself to the preparation of a draft directive that would meet the objective. At present, this draft is undergoing informal checking with scientific and technical personnel of the Department of Defense. If a favorable reception is given to the proposal, it will be coordinated formally.

B. *Security criteria guide*

A proposal is under consideration, and study begun, for the establishment of an open-ended guide or catalog which would provide a uniform criteria as a reference for all individuals charged with downgrading and declassification responsibilities, and for Public Information Officers, as to what types of information in specific categories are classified or unclassified. The Director is of the opinion that there is room for substantial improvement in the guidance as to what type of information should be classified.

C. *Plan for accelerating the flow of basic and applied military research information to technical colleges*

In December 1957, a plan was proposed for utilizing downgrading and declassification techniques to make available to college scientific and technical ROTC students basic and applied research information developed in connection with military research, development, and production contracts for weapons systems. The Deputy Director has arranged an exploratory conference with the President and faculty of a leading technical school to define areas of interest to the colleges. Some major objectives of the plan are:

1. To provide the United States, in a much shorter period of time, with scientifically and technically trained manpower in greater quantity, and with a much higher level of knowledge of advanced development in science and engineering resulting from research performed on technical military projects.
2. To encourage more technically minded students to enroll in the Reserve Officers Training programs and to stay in the military service for longer periods of time after graduation.
3. To build up a reservoir of scientifically and technically trained personnel for Government, industry, and our colleges, with a much higher level of knowl-

edge in the most modern and advanced scientific techniques than is normally available now from the graduating classes of our technical schools and universities.

4. To develop means for the rapid flow of basic scientific information to the colleges so that the faculty, graduate, and undergraduate students can contribute needed ideas and talents to national defense.

5. To encourage college faculty members to participate more fully in Government basic research programs, and provide the scientific leadership necessary to open up new research horizons and avoid costly scientific blunders.

6. To insure the technical supremacy, and thus the security of this Nation in the years to come, by providing a versatile supply of scientists and engineers capable of developing defensive weapons and the industrial power of this country to such a point as to deter the ambitions of any potential enemy.

J. M. Hoskins,
Vice Admiral, USN (Retired),
Director of Declassification Policy.

NOVEMBER 1957

OFFICE OF THE SECRETARY OF DEFENSE
OFFICE OF ASSISTANT SECRETARY (PUBLIC AFFAIRS)
OFFICE OF DECLASSIFICATION POLICY

OFFICE OF THE DIRECTOR
Director - V/Adm. J. M. Hoskins, USN (Ret'd).
Deputy Director - J. Clifford Johnson.
Secretaries - Genevieve La France.
Sharon Del Vecchio.

Under direction of Assistant Secretary of Defense (Public Affairs) and within the framework of Executive Order 10501, as implemented by Secretary of Defense, originates, directs, and monitors an overall Department of Defense declassification program as prescribed in DOD Directive 5105.12. Director serves as chairman of Declassification Policy Committee.

OFFICE OF EXECUTIVE SECRETARY
Executive Secretary - Curtis G. Meade.
Secretary - Betty Wells.
Clerk-Courier - A/1C George Guidas.

Assists the Director in planning and conducting Committee meetings, organization of subcommittees and work groups. Makes recommendations as to areas to which the Committee should direct its attention. Maintains continued familiarity with & coordinates pending projects. Prepares agenda and briefs Director and other members of Staff concerning matters to be considered by the Committee and suggests possible solutions or appropriate action. Prepares minutes and follows up on decisions and required actions. Responsible for internal administration including communications, records, office supplies & equipment, personnel, budget, etc.

SPECIAL ASS'T FOR TECHNICAL PROGRAMS
Vincent C. Tompkins

Develops and recommends policies, procedures, programs, guidelines and instructions for timely downgrading and declassification of technical information. Maintains liaison with military departments, other executive agencies, and industry. Advises other staff officers, particularly the Director of Current Programs and Director of Future Programs on the effect of proposed policies under their programs and their impact on industry. Confers with scientists, engineers, technicians, and other experts as necessary with regard to these activities.

CURRENT PROGRAMS DIVISION
Director - W. W. Harrison, Jr.
Analyst - George Collins.
Secretary - Mary Pepe.

Develops and recommends new or revised programs, policies and instructions designed to downgrade or declassify information currently under security classification. Designs & establishes reporting systems to measure effectiveness, efficiency and progress of declassification program. Evaluates these programs & prepares appropriate reports for the Director, Ass't. Sec'y. (PA) & other officials.

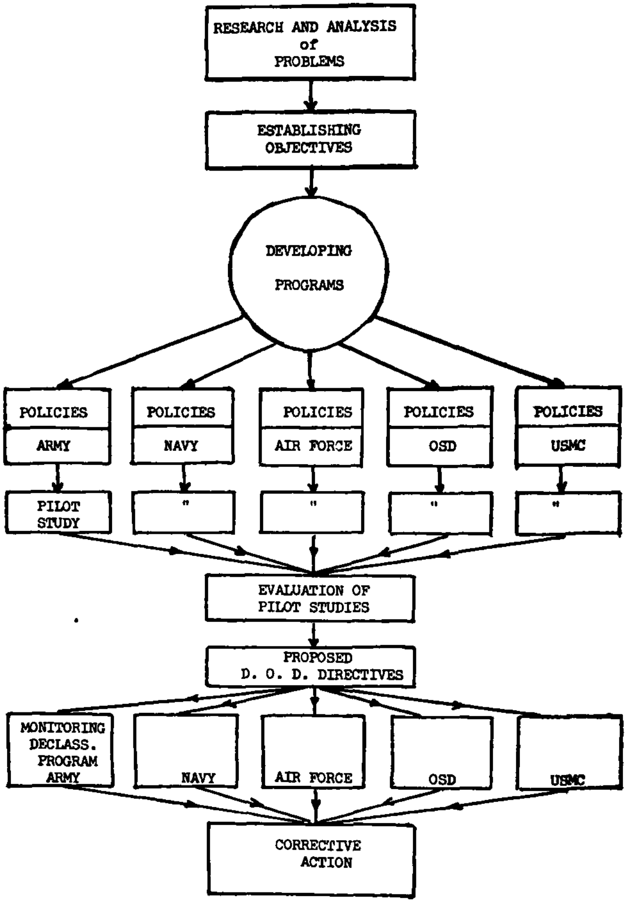
MILITARY ADVISORY STAFF
Col. Richard Hayward, USMC.
Col. John Ferris, USA.
Col. Edward Butler, USAF.
Capt. Gordon Egbert, USN.

Advises Director concerning security matters generally, and classification & declassification specifically, pertaining to each military department. Maintains close liaison with appropriate area of each military department in order to be constantly acquainted with pertinent policies, regulations, & procedures affecting the program of the Office of Declassification Policy.

FUTURE PROGRAMS DIVISION
Director - Hunt Clement, Jr.
Secretary - Ida Mabie.

Responsible for conducting surveys & studies & developing policies & procedures relating to declassification & downgrading of material to be created, as distinguished from current material. Studies patterns relating to long-range problems & is particularly concerned with plans relating to automatic action to prevent further buildup of backlog.

OFFICE OF THE SECRETARY OF DEFENSE
OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE (PUBLIC AFFAIRS)
OFFICE OF DECLASSIFICATION POLICY



DEPARTMENT OF THE NAVY

BUREAU OF NAVAL PERSONNEL

WASHINGTON, D. C.

BUPERS INSTRUCTION 1533.48

From: Chief of Naval Personnel.
To: Distribution list.
Subject: Security of classified matter; information concerning.
Reference: (a) OPNAV INST 5510.1A, U. S. Navy Security Manual for Classified Matter.

1. *Purpose.*—The purpose of this instruction is to insure that training programs conducted by addressees stress the importance of security; including the adverse effects of improper classification.

2. *Background.*—The responsibilities for handling classified information commence early in the life of a newly commissioned officer, especially today when junior officers are called upon to assume duties normally assigned to higher ranks. These responsibilities continue throughout an officer's career in different positions. Among these is the initial responsibility of assigning classifications to correspondence and documents. The lack of experience and fear of reprisal for improper classification generally results in overclassification which not only compounds stowage and handling requirements involving excessive costs in manpower and money, but also detracts from the importance of classification in the minds of all personnel.

3. *Action.*—Addressees are requested to insure that training programs under their cognizance include instruction regarding security of classified matter and that instruction also covers overclassification as set forth in article 0402 of reference (a) and as discussed in paragraph 2 above. It is envisioned that such instruction can be accomplished within the existing framework of course topics. The instruction should be repeated from time to time as appropriate.

J. R. LEEDS
(By direction).

NAVAL TRAINING BULLETIN

February 1958

OVERCLASSIFICATION IS A VIOLATION

LCDR G. B. Tamburello, Training Division, BuPers

Recently VADM J. M. Hoskins, USN (Ret.), was appointed Director of Declassification Policy for the Department of Defense and given the responsibility of declassifying the huge amounts of material held by the Armed Forces in an effort to reduce costs of stowage of such material and to make available to scientists and historians information which is no longer of military value. His task is tremendous—and yet the same problem will be faced continuously unless we learn now how to classify properly and retain that know-how.

First, every one must understand the requirements for each classification as established in the Security Manual. The axiom, "when in doubt, classify," is not a good one. Overclassification compounds stowage and accountability problems; it depreciates the importance of properly classified matter; and it detracts from the importance of classification in the minds of all personnel.

What are some steps to minimize improper classification of matter?

(*a*) Require personnel who initiate correspondence to reread the rules for proper classification.

(*b*) Question critically the assigned classification originated by your office personnel.

(*c*) Question and challenge, if necessary, the classification of material received from other activities.

Matter which is overclassified should be brought to the attention of the originator—just as is done when classified matter is not handled properly. This use of discrepancy reports can create a consciousness of and proper attitude toward classification. The Security Manual, article 0408, states the proper procedures for reclassifying matter.

SECURITY CLASSIFICATION GUIDE

Use the lowest classification consistent with the proper safeguarding of the information. Before you classify, ask yourself—if this information were in unauthorized hands:

—could it result in exceptionally grave damage to the Nation? Then it is Top Secret.

—could it result in serious damage to the Nation? Then it is Secret.

—could it be prejudicial to the defense interests of the Nation? Then it is Confidential.

(See below for definitions of the three categories.)

Classified information—does not have to remain classified. Periodically—review the material you have classified with a view toward downgrading or declassifying it, if appropriate.

Use "automatic downgrading" markings, whenever possible.

Overclassification—

Hampers freedom of information,
Weakens the classification structure,
Overburdens storage facilities,
Delays handling of documents.

CLASSIFICATION CATEGORIES

Information which requires protection in the interests of national defense is limited to three categories of classification:

Top Secret

Information or material, the defense aspect of which is paramount, and the unauthorized disclosure of which could result in exceptionally grave damage to the Nation such as leading to a definite break in diplomatic relations affecting the defense of the United States, an armed attack against the United States or its allies, a war, or the compromise of military or defense plans, or intelligence operations, or scientific or technological developments vital to the national defense.

Secret

Defense information or material the unauthorized disclosure of which could result in serious damage to the Nation, such as by jeopardizing the international relations of the United States endangering the effectiveness of a program or policy of vital importance to the national defense, or compromising important military or defense plans, scientific or technological developments important to national defense, or information revealing important intelligence operations.

Confidential

Defense information or material the unauthorized disclosure of which could be prejudicial to the defense interests of the Nation.

NOTICE

REQUEST THIS FILE BE REVIEWED FOR POSSIBLE REGRADING OF THOSE DOCUMENTS WHICH WERE ORIGINATED BY PERSONNEL OF YOUR DIVISION/OFFICE

NOTE.—If regrading action is considered appropriate, it is requested that action be taken in accordance with paragraph 94, AR 380–5, and recipients of the original document notified in accordance with paragraph 93, AR 380–5. It is further requested that notification of action taken be furnished Administrative Division, Mail and Records Branch, on attached IRS. For additional information contact Ext. 71068.

HEADQUARTERS U. S. MARINE CORPS

WASHINGTON

ADMINISTRATIVE DIVISION

HQO 5511.7
ABQ–glt
1 Nov 1957

HEADQUARTERS ORDER 5511.7

Subject: Declassification or regrading classified material originated within Headquarters United States Marine Corps during the year 1955
Reference: (a) Paragraph 0411 OPNAV INSTN 5510 1A (U. S Navy Security Manual for Classified Matter). (b) HQO 5511.4 of July 5, 1957.

1 *Purpose.*—In order for this headquarters to comply with the provisions of reference (a) in that classified matter will be reviewed for declassification or regrading prior to being forwarded to the Records Retirement Center and to further the declassification and regrading program established by reference (b).

2. *Action.*—Heads of divisions and departments will direct, on the day(s) indicated below, one or more qualified representatives, authorized to review and mark for declassification or regrading, the 1955 documents issued by their respective agency, presently held in the Classified Files Section (room 2109).

Fiscal—November 4.
Inspection—November 5.
Reserve—November 7.
Discipline—8 November.
G–1—November 12.
G–2—November 14.
G–3—November 18, 19, 20.
G–4—December 4, 5, 6.
Aviation—November 21, 22.
Supply—November 15.
Personnel—November 25, 26.
Administrative—December 2.

The Head, Secret and Confidential Files Section, will issue necessary instructions to the Division or Department representative or representatives at the time of arrival as to procedures required in this process and will render assistance in anyway necessary.

3. *Information.*—This order in no way modifies or alters the provisions of reference (b).

4. *Cancellation.*—The provisions of this order are cancelled when all 1955 classified material has been reviewed and for record purposes on February 1, 1958.

By direction of the Commandant.

W K. ENRIGHT,
Colonel, United States Marine Corps,
Director, Administrative Division.

CHANGE IN UNITED STATES MARINE CORPS SECURITY MANUAL

0404 PROCEDURES FOR RECLASSIFICATION AND DECLASSIFICATION

1. A program for reclassification or declassification of classified material originated within Headquarters, U S. Marine Corps will be administered by the Head, Secret and Confidential Files Section on a continuing basis

a Top Secret documents which are to be considered for reclassification or declassification will be transmitted to the Classified Material Control Officer of the cognizant Department, Division or Separate Office in groups of ten or less under cover letter. A new buck tag will be attached to each document and a

rubber stamp indicating action to be taken will be stamped thereon. The officer assigned by the Department, Division or Separate Office to process the classified material and recommend the reclassification or declassification action to be taken will check the appropriate space and sign. Documents will then be returned to the Head, Secret and Confidential Files Section as a complete package with cover letter attached and first endorsement executed. The cognizant Department, Division or Separate Office processing classified material for reclassification or declassification which must be coordinated with other Departments, Divisions or Separate Offices will route the classified material via the Secret and Confidential Files Section. Such routing is to be indicated on the buck tag with code symbols to insure return to the cognizant Department, Division or Separate Office. When material has been processed and returned to the Head, Secret and Confidential Files Section, he will take the necessary action to reclassify or declassify the classified material so recommended for such action and will notify holders of that material. After processing and reclassifying or declassifying action has been taken, the documents will be routed, by endorsement on the cover letter, to the Assistant Chief of Staff, G–3 (Historical).

b. Instructions for the review of Secret and Confidential documents, originated within downgrading or declassification, will be published in Headquarters Marine within Headquarters Marine Corps, for possible downgrading or declassification, will be published in Headquarters Marine Corps directives.

Mr. FELDMAN. Now, you spoke of several programs. Are they in the program stage or are they at a stage where they are in effect and beginning to work or are working?

Mr. NIEDERLEHNER. The several programs which are set forth in the basic Executive order are presently in effect. And those are the programs with respect to which the Hoskins group has already been working with the services and has been obtaining reports on volumes and changes in procedures for marking, changes in responsibilities of individuals, for examples; the level of authority at which downgrading can be undertaken; all of these things are current programs, currently in effect.

And attention is being invited to them by the Hoskins group, in a committee which he has on declassification policy, where the services meet with him in an effort to continually concentrate attention on this program.

The other major step, the attempt at the bulk automatic declassification, is not currently in effect. It has been under study for quite some time. And we hope that very shortly it will be in the form of a positive directive.

It is actually in the final stages at the moment.

Mr. FELDMAN. That is all.

Mr. NATCHER. Mr. Fulton.

Mr. FULTON. I have first the request, Mr. Chairman, to put some material in the record following Professor Cooper's testimony on yesterday as well as the material I am going to request now.

Mr. NATCHER. Without objection it is so ordered.

Mr. FULTON. I would like to put in the record Professor Cooper's precedent-setting lecture delivered in 1951 in Mexico City before the Independent Law Faculty when Professor Cooper was present in Mexico City, as observer in respect to the Legal Committee of the Civil Aviation Organization.

(The above-mentioned paper is on p. 1327.)

Mr. FULTON. Likewise, I would like to have the staff get from the RAND Corp. a summary of the highlights of the RAND Corp.'s bibliography on space which I believe is authoritative.

Might I ask the witness 1 or 2 questions today.

The problem comes up on the setting of a civilian space agency: What will be the relation on classified and secret or confidential material between that civilian Space Agency and the military agencies who are operating on behalf of the Department of Defense; for example, ARPA? What kind of liaison relationship will be there with respect to classified, secret, and confidential material?

Mr. NIEDERLEHNER. I do not know, Mr. Fulton, that a specific formal arrangement need be made.

Mr. FULTON. Could you put that in the record, rather than giving it offhand?

Mr. FELDMAN. As soon as possible, because we want to have the record printed.

Mr. FULTON. Yes. But I think it is better that they be careful about it.

Mr. NIEDERLEHNER. Although I would like to answer in detail, I would like to refer back to my previous statement with respect to overall access to classified information.

I am certain that this agency operating in the field of space will require information both in the atomic-energy field and in the defense field and certainly will be granted access to it.

Mr. FULTON. So that whether it is a completely civilian program or one that is being operated in cooperation with or in behalf of the Department of Defense, there will be access to classified and secret or confidential information?

Mr. NIEDERLEHNER. In accordance with the Executive order, yes, sir; the only standard being the national defense. Whether you go beyond that to a formal type of liaison committee, such as the Military Liaison Committee with the Atomic Energy Commission, which has proved to be very effective, or whether a less formal arrangement is made——

Mr. FULTON. That is part of my question. What kind of implementation would you set up?

And I would rather have your considered views than your offhand views at present.

Mr. NIEDERLEHNER. We will submit those.

Mr. FULTON. As the counsel says, we should submit it—how soon?

Mr. FELDMAN. Yesterday.

Mr. FULTON. Let us finish with this. The problem will come up on research, development, and exploration in outer space as to what kind of a classification there should be for basic scientific material.

There are some of us who want a prompt release of basic scientific material, whether the basic scientific research has been in ARPA or NASA, the new agency.

And likewise we would like to set up some sort of a method of scientific exchange among countries, whether countries of the Free World or all the countries of the world.

Could you—not now, but later—submit a statement as to how you would recommend the handling of basic scientific research material?

Mr. NIEDERLEHNER. Yes, sir.

(The material requested of Mr. Niederlehner follows:)

During the course of the testimony, Mr. Fulton requested that I furnish comments with respect to two matters: (1) Whether or not the relationship between the new Space Agency and the Department of Defense should be through a formal liaison, such as the Military Liaison Committee; and (2) the method of

handling basic scientific material and whether or not it should be protected from general dissemination.

With respect to the first question, the Military Liaison Committee has proved a most effective device for covering matters of common interest between the Atomic Energy Commission and the Department of Defense. However, the formality of this arrangement arose out of the unique relationship of atomic-energy activities to national-defense interests and security matters. We do not believe that a parallel situation exists with respect to the proposed National Aeronautics and Space Agency. We visualize the relationship as similar to that which the military departments have with the National Advisory Committee for Aeronautics which performs functions from which both private and military benefit in the scientific field. I have been advised that liaison has already been established between the Department of Defense and NACA with respect to space matters and is operating very satisfactorily. Accordingly, no formal statutory military liaison committee appears to be necessary.

With respect to the treatment of basic scientific material which may be produced during the course of the work of the new National Aeronautics and Space Agency, it is the position of the Department of Defense that the so-called pure scientific information should be made generally available in the exchange of ideas and information to stimulate overall progress in the basic sciences. It is only when a military application of scientific information develops that the necessity for safeguarding against general dissemination arises (in the interest of avoiding dissemination to potential enemies).

The basis for a special formal system of protection of atomic energy information as "restricted data" was the conviction that this information was the most highly sensitive military information, whereas much of the information developed by the new agency will be of general overall scientific interest. If, as suggested above, the relationship with the Space Agency will be similar to the relationship of the military with NACA, then, in my opinion, it will be practicable to separate the purely scientific aspects of the Agency's work from the military applications. The system for the entire executive branch prescribed by Executive Order 10501 will be adequate, and a formal statutory system of restriction on information will not be necessary.

Two other factors persuade me toward this conclusion. In the first place, the system of restricted data imposes a substantial burden in the interrelationships of agencies, and it should be imposed on the basis of strictest necessity. Secondly, in the interest of overall scientific advance, we should not add to the law an additional system of restriction of information unless this is absolutely necessary.

Mr. NIEDERLEHNER. Could I just point out in passing that the Congress dealt specifically with this problem in the Atomic Energy Act. Whether this was because there was a question as to whether or not all information relating to atomic energy had defense significance the Congress made the decision that it would specifically provide the safeguards for the atomic-energy material whether you could demonstrate a specific military application or not.

Mr. FULTON. I have been interested ever since the early part of last year in setting up some kind of an agency that would be similar to the Atomic Energy Commission. I also favored a joint legislative space committee operated along the lines of the Joint Committee on Atomic Energy.

The point of my question is that we should likewise give our attention, just as we did on atomic energy, to the proper approach of Congress to basic scientific research and scientific knowledge.

This committee has to recommend the policy for the exploration of both astronautics and aeronautics in outer space.

That is all, Mr. Chairman.

Mr. NATCHER. On behalf of our chairman, Mr. McCormack, I want to thank you, Mr. Niederlehner, and also you, Colonel Rubenstein, for the fine statements you have made to our committee and for your appearance at this time.

The committee will stand adjourned until 2 o'clock this afternoon, at which time we will hear Mr. K. T. Keller, former president and board chairman of the Chrysler Corp.

(Whereupon, at 12:16 p. m., the committee recessed, to reconvene at 2 p. m. the same day.)

AFTERNOON SESSION

(The committee reconvened at 2:13 p. m., the Honorable John W. McCormack, chairman of the committee, presiding.)

The CHAIRMAN. The committee will be in order.

The next witness, and I might say the last witness of the public hearing—last but not least—is K. T. Keller, former president and board chairman of the Chrysler Corp., of Detroit, Mich.

We are very glad to have you with us, Mr. Keller.

Mr. KELLER. Thank you, Mr. Congressman.

The CHAIRMAN. And we kept you until the last because we felt that your contributions could be very effective before we go into executive session.

Before recognizing you, I yield to the gentleman from Pennsylvania, Mr. Fulton.

Mr. FULTON. We are glad to note the presence here of the students of the senior class of Allegheny High School near Pittsburgh, Pa. Many of them are interested in the rocket and space exploration field. So here is a class en masse showing their interest in the future and in this select committee's work.

Thank you very much.

The CHAIRMAN. As chairman of the committee I am also glad to note that you are here. You young Americans are the ones that we look to to be the leaders in our Government in the years ahead.

We know that with your loyalty and your faith that you will take the right journey through life and preserve in your day the government and laws which we were fortunate to inherit from past generations of Americans.

I am very glad to see you here and hope you will benefit from being present and seeing democracy in operation in its most effective form—legislation emanating in a committee of Congress, in this case a select committee, on legislation of far-reaching importance in the years that lie ahead, not only for our country but for the world in general.

I again say that I hope you will soak in the atmosphere. I can remember myself when I was about your age, that I never thought I would be in Congress. I never thought I would be majority leader or chairman of this committee. Who knows what life holds in store for any one of us?

And if I might make an observation: I can remember when I was your age, I always said I am going to be the best. And if I wasn't the best, at least by trying to be the best, I was much better than I would have been if I hadn't tried to be the best.

So, I hope you will soak in the atmosphere of a free country where you and I are free men and can be free under the law. And that is the real isthmus between our form of government and the totalitarian form of government that is undertaking to dominate the world where human beings would be mere cogs in the machinery of the state. But here the state or government is the servant of the people.

Mr. Keller, we are very glad to hear from you.

STATEMENT OF K. T. KELLER,[43] FORMER PRESIDENT, CHRYSLER CORP., DETROIT, MICH.

Mr. KELLER. This is on the matter of outer space, space platforms, and satellites, and things of that nature that you are inquiring of me, I presume?

The CHAIRMAN. Yes. Have you a prepared statement?

Mr. KELLER. No, sir.

The CHAIRMAN. You wish to submit to questioning?

Mr. KELLER. Yes, sir.

The CHAIRMAN. Well, suppose we have the chief counsel and director, Mr. Feldman, start asking you questions to lay a foundation.

Mr. KELLER. That is satisfactory.

Mr. FELDMAN. Mr. Keller, you have had a great deal of experience in organizations, in the running of large organizations. Is that right?

Mr. KELLER. I grew up in it, sir.

Mr. FELDMAN. And are you acquainted at all with the legislation before this committee at this time?

Mr. KELLER. Which legislation is that?

Mr. FELDMAN. The President's proposal concerning a space agency.

Mr. KELLER. No, I don't think I have that one. I have the one on reorganization of the Pentagon, which I read several times. But I haven't got the one on this space agency.

The CHAIRMAN. We will keep away, if you don't mind, from the reorganization of the Defense Department.

Mr. FELDMAN. Mr. Keller, you have had a great deal to do with the Defense Department's missile program?

Mr. KELLER. 37 months, sir.

Mr. FELDMAN. Could you tell the committee what your experience was in that connection?

Mr. KELLER. I was requested by Louis Johnson, who was then Secretary of Defense, to come down and see the President. I tried to find out what it was about. But he said "You will find that out when you get here."

He met me at the airport and took me over to the White House. And President Truman outlined to me in general the work that was being done on guided missiles and how important he thought it was to the country, and that he thought there was a great deal of money being spent on it.

He did not know whether we could make any savings. But he was quite sure that it could be moved along faster.

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[43] Keller, Kaufman Thuma, chmn. Chrysler Corp , b. Mount Joy, Pa., Nov. 27, 1885; s. Zachariah W. and Carrie (Thuma) K , ed high sch., Mount Joy, and bus sch , Lancaster, Pa ; m. Adelaide Taylor, Sept 21, 1911, children—Robert, Richard. Sec to lectr and author, traveling in Brit. Isles, 1904–06; machine shop apprentice Westinghouse Electric & Mfg. Co., 1906–08, asst. supt. automobile engine dept., 1909–10; chief insp Detroit Metals Products Co , Detroit, 1910; gen foreman of machine shop Metzger Motor Car Co , Detroit, 1910–11, with Hudson Motor Co., Detroit, and later chief insp. Maxwell plant, Tarrytown, N. Y., 1911; became asso with Gen Motors Co , Nov. 1911, worked on Cadillac and became supt. Northway Motors, 1915, gen master mechanic Buick Motor Co., 1916–19, mem. mech. and engring. staff Gen. Motors central office, Detroit, 1919–21, v. p Chevrolet Motor Co , 1921–24, gen mgr Canada, 1924–26; with Chrysler Corp since Apr 1926, v p in charge of mfg , 1926–35, pres , 1935–50, chmn. bd. since 1950. Trustee of the Hanover Bank, dir Nat. Dairy Products Corp. *Dir. guided missiles, office, Sec of Def., 1951* Mem. Army Sci Panel, Detroit commn Fgn Relations, Dir Am Ordnance Assn , Automobile Mfrs. Assn Awarded Medal for Merit, Pres U S , Masonic Order's Gourgas Medal, 1952 Industrialist of Yr., Soc Indsl. Realtors, Army Ordnance Distinguished Service Certificate Mem. Detroit Indsl. Safety Council, A. S. M. E., Soc Automotive Engrs , Nat Air Council, Navy League, Nat Aeros Assn , Newcomen Soc., Yachtsmen's Assn Am. Methodist Clubs Detroit Athletic Club, Detroit Golf Club, Bloomfield Hills Country, Old, Grosse Pointe Yacht, Recess, Detroit (Detroit), Bohemian (Calif); Key Largo Anglers (Fla.); 29 and Cloud (N Y), Office; Chrysler Corp., 341 Massachusetts Av , Detroit, 31.

And he asked me if I would undertake to do the work. At that time he said "I think we should put our emphasis on defense missiles in particular" and suggested that maybe I would find out that there would be other missiles that should receive attention. I told the President that he was speaking to me of something I knew nothing about, and I could not very well give him an affirmative answer.

But I told him if he would tell me where I could look this matter over I could then tell him whether I thought I could do anything about it.

I did tell him at the time that if I felt that I could do anything about it, I would have to do it the way I thought it had to be done. And he told me that if I came to the conclusion I could be of help to him I could do it any way I wished to do it.

So, I spent some time at the Pentagon Building. And with the help, particularly of the head of the research and development, Mr. Webster, I got a line on what they were attempting to do and the scope of the job. And I found that at that time there were about 4,000 people in the services on guided missile work and about 11,000 in the contractors' places of business.

And I felt at the time that to organize a group of that size would take at least a year and maybe a year and a half, and that the best thing to do would be to work with those people with a small competent staff of our own to try to give it guidance and direction.

And I wish to say that is the basis on which we did the job. And they put me in the organization as a consultant and adviser to anybody that had anything to do with guided missiles.

And we operated on that basis. I selected a small staff of capable men. All of them were in uniform, excepting one man I brought in—an astronomer—on the Atlas job. And we proceeded to go from there.

The complexion of the Defense Department changed considerably. I operated under four Secretaries of Defense. Mr. Johnson went out shortly after I got there. And General Marshall came in. And he was succeeded by Robert Lovett, who was there most of the time.

And I stayed on for a number of months after Secretary Wilson came into the picture.

Now, I do not know what else you would like to know.

Mr. FELDMAN. What was the state of the art when you undertook this?

Mr. KELLER. Well, the state of the art when I undertook it was that we had no missiles of supersonic speed that had their guidance system completed to the place where they could show their capability or prove that the concept was correct.

Mr. FELDMAN. What missiles were developed during the time you were head of this project?

Mr. KELLER. Well, I felt that with my past experience that I have had with development work, that there is one phase of the program that was being overlooked. And that was though our conceptions may be of the very greatest and best, there always comes a time in an engineering, mechanical development where you run into what I choose to call the dirty, stinking work of getting the little problems cleaned up.

And that meant that you had to stabilize your objectives long enough to get hardware and to find out what made malfunctioning in a piece of mechanical apparatus.

For that purpose we picked out three missiles as example missiles to concentrate on and see what we could do to get them into a state of reality. One of the great troubles that you have with the people of the conception department on these thing, is when they run into a little trouble—and particularly if your tests are months a part—they have a lot of time on their hands and they dream up a new one, and always with the belief the new one is going to be better than the one that they had before.

I guess it is somewhat like the next child is going to be the favorite child of the family. But you have still got to raise them. And so we took that approach. And that began to set a little different pattern and a little different approach. And we were able to get very splendid cooperation from the uniformed services, because they sat down and discussed the problems.

Let's take, for instance, the Nike missile, which is the one I think you may be most familiar with. I think the country is most familiar with that one. Our first survey of that job in, I think, November of 1950 indicated that it would have its first full-scale test in the spring of 1955, which seemed to be quite a long time.

But we stayed in conference with the people that were responsible for the development of it long enough and steadily enough to determine that one of the causes of this great delay was the fact that the specifications were changed.

They were pretty well through with their exploratory work, their theoretical exploratory work; so that the Nike would be a very successful missile at the 25 miles and 60,000 feet range; but the specifications or objectives were then moved up on them to 35 miles and 75,000 feet, and that meant a whole new exploration.

Well, in our discussion with the services and with the contractor, we developed the fact that there wasn't any radar completely developed that would detect a target in time to use the 35 miles. There was nothing flying even at 60,000 feet. We had nothing that would shoot an airplane down at anywhere near 25 miles.

So, we came to the conclusion—and it was a mutual one—that if we were to take the original specification of 25 miles and 60,000 feet, that we could get into this hardware stage and begin to learn and get the assurance that comes from doing and accomplishing, and getting a missile, that would be of considerable use, realizing that in this art of defense nothing is permanent.

We even improved the rifle; and any step you take is just one step on the ladder of progress that you make. I told them at the time that in doing that job just as soon as they were ready to explore going 50 miles, that I would be back of them to the limit in getting that job done. Well, the result was that we now have the Nike-Ajax, and had it in operation. It had its full-scale test in early 1952, I think.

When we turned it over for production, they had 7 hits out of 8 shots at White Sands, which we thought was conclusive evidence that the missile would work. And it would be purely a matter of the mechanics of making it and duplicating it. So it would have reliability to be a very effective weapon.

In that time the Nike-Hercules, which has a great deal more range and which range I will not now disclose, has come in and is ready for operational use.

I think they had been working about 4 years on Nike when I came into the picture. I just give that as illustration that you go up this ladder one rung at a time. And I believe there is a third Nike of very important defense possibilities that is now coming along very rapidly.

But I have the very deep conviction that the success we had in proving that minute detail—and, after all, no matter how big a thing is, it has a large collection of detail—proving that detail and learning the art of making it and having the proper concept of the importance of all the little things that go into the job, that formed a platform for both the people that were making it and the using services to understand it and coordinate their work.

And I believe the future Nikes have come along with great saving of time and money by that process. I still belive so.

Does that answer your question?

Mr. FELDMAN. Yes, it does.

In other words, you started from scratch? You had no experience in the missile field?

Mr. KELLER. I didn't know there was a missile around, when Louis Johnson called me.

Mr. FELDMAN. But you did have great experience in running large organizations in the production field?

Mr. KELLER. I have had a lot of experience working with engineers, yes, sir.

Mr. FELDMAN. When you undertook this job, did you assemble some scientists or were they already assembled?

Mr. KELLER. Well, no. I assembled them. I had the, I think, distinct privilege of having the job of making the equipment that separated the isotopes of uranium at Oak Ridge in the absorption process.

We started from scratch on that. And I had a lot of experience with General Nichols, whom I think you know. So, I asked to have General Nichols as my Deputy, which was quite, perhaps, the hardest thing I had to do in connection with the whole field.

But I got him. And then from there we picked up the balance of the organization. I have got here, I think, a paper somewhere. This happens to be the final report that I turned in just before I left the job in 1953.

If I will read this report—this is the only copy I have, and I would like to keep it for my files. I could have it reproduced and send it to you. But maybe if I read it to you—it isn't very long—you will get an answer to a lot of your questions.

Mr. FELDMAN. I would like very much to have it.

Mr. KELLER. August 30, 1950, when the then President requested me to see what I could do to advance the guided-missile program, he agreed to give me wide authority.

Examination of the program showed there were about 4,000 people in the service organizations and 11,000 in contractor and private organizations working on guided missiles. After 90 days of study, including considerable traveling, I felt the best immediate progress and longtime benefit would come from a small organization which

would act as a consultant and adviser to everyone having anything to do with the guided missiles.

This approach worked into a recommendation of a program to be followed on each of the guided missiles.

Our recommendations were submitted to the Secretary of Defense and were approved by him in every case. We received excellent cooperation from the services who handled the administrative work as well as from the research laboratories, engineering organizations, and the contractors engaged in the multitudinous segments of these weapons and their systems.

A small staff was furnished me by the then Secretary of Defense and the three services—Army, Navy, and Air Force. Maj. Gen. K. D. Nichols, United States Army, became my Deputy, and has been with this work continuously since my office was created.

Dr. Robert R. McMath, director of the McMath-Hobard Observatory has acted as a consultant to me since 1951. The other members of this staff were as follows:

And I list here first the Army and the term that they had with me. And I had 3 at one time; sometimes 2.

Colonel White, Colonel Lawless, Colonel Skinner, Colonel Trainer, and Sergeant Krimms. Sergeant Krimms was our security officer.

From the Navy I had Colonel Lumis; Captain Sydes, now Admiral Sydes; Captain Clark, now Admiral Clark; and A. S. Bourne, captain.

From the Air Force I had Brigadier General Robey, Colonel Terhune and Colonel Wetsell.

We started with a staff of 6 military personnel and 2 secretaries. This was shortly increased to 8 and 2 secretaries.

Now the staff consists of 4 full-time and 1 part-time, plus 1 full-time and one part-time secretary. Our Navy berth has been vacant for several months, but the Navy has people who are made available for conferences and inspection trips.

The turnover in personnel is occasioned by the necessity of officers going to other duty in accordance with the established procedures of the services.

In 1950, top priority, as indicated by the Joint Chiefs of Staff, was for defense weapons. The others were still high on the list.

The close examination and study of the whole program, as well as the individual missiles, indicated the wisdom of keeping guided missile study and development as an integral part of the defense and military program.

A reading of the prospectus of any one of these missiles will almost sell it to the using services. The problems of having them perform is a laborious undertaking. Early tests were very disheartening. Aerodynamics and propulsion came along faster than guidance.

Each test that showed failure or even success stimulated new ideas. Failures in tests gave birth to many new conceptions and often new performance possibilities.

Changes in plans and objectives were coming so fast that it was difficult to establish a set of performance characteristics we could stay with long enough to develop a satisfactory weapon.

We early in the first year picked out the Nike, the Terrier, and the Sparrow, all air defense missiles, to work out a program that would bring the overall program along faster and establish just what could be expected of a guided missile.

The Nike-system tests with flying targets was advanced from 1954 to the winter of 1951–52, or about 2 years. This was accomplished by reducing and freezing the performance specifications at the level that it then seemed most likely could be met.

Minimum production setups were authorized on these three missiles so we could get the influence and interests of the production engineer and the master mechanics into the program. It was very evident that hundreds of missiles would have to be tested before we could get the design stabilized and the malfunction chased out of the missile components.

By making missiles for test on the production line, we not only trained the production crews but saved many dollars in the cost of the missiles.

While pushing Nike, Terrier, and Sparrow, we also gave attention to every guided missile the service sponsored. We traveled many miles, held hundreds of meetings with the contractors, laboratory suppliers, and the testing centers and research locations.

We covered each important point of contact at least twice a year. We kept our recommendations current to the condition of development that we considered the missile to be in. The below listing of missiles gives our current thinking on each.

And we have divided these into the three main divisions basic in bringing along any new project and conception to reality. That is to say, research, development, and production.

We further defined each of these divisions as follows: Research is the stage during which theoretical feasibility is proven. Development takes theories coming out of research and brings them along to the point of demonstrating they are practical under controlled conditions. And third, production is the stage in which processes are set up to provide reliable technical equipment to the fighting men and good efficiency and economy.

I think the balance of the memorandum I should read:

Now that Secretary Wilson is building an organization to place the supervision of guided missiles into the administrative department of the Office of Secretary of Defense I have some observations that may be useful to them. I feel strongly that the services should continue to handle the detailed planning and administration of the projects. The coordination of the services should be guided through the Office of the Secretary of Defense.

We always felt that each guided missile, while sponsored by a particular service was nevertheless for all of the services. There are some specific areas of practices that we believe should be overcome in the best interest of the needed rapid progress in missile development. First of all the military should be ready to yield when the insistence on what might be called minor logistic improvements can be shown to complicate and delay development. We must get a workable article first. This will never materialize if we adhere too rigidly to the practice of reaching only for the ultimate in design possibility.

Second, the performance characteristics having been chosen within the reasonable reach of science must be adhered to.

Scientists and engineers worth their salt are always looking ahead toward better things. Control, however must be exerted, so that such changes in specification do not unnecessarily delay achievement of the primary goal.

That is of getting the tactical usable weapon.

The debugging stage in any development is always dirty, exasperating work. It isn't glorious nor glamorous or easy. So an improvement in design is always attractive as a way out of the immediate trouble.

Finally delays in taking remedial action when signs appear that a project is running into trouble must be reduced.

Frequently these troubles are generated by the type of organizational structure engaged in the project. At the very least every project involves a coordinated effort of a military department, a prime contractor and several subcontractors.

The problem of coordinating this effort is like that of running an industry whose parts are scattered all over the country. Project directors of the services must practically live with their projects in the field for only there can the true picture be seen and evaluated.

Medicines needed must be applied promptly rather than allowing situations to deteriorate to the point where the only cure involves surgery.

A greater reliance of the services on the vertical organization for important projects would help.

In conclusion I thoroughly believe that the progress to date warrants everyone being friendly to the missile development program. I further believe that someday they may be our most useful weapons.

Overenthusiasm can also do the program harm. Now is the time for friendly but realistic application of our money and manpower to this work. This is what we have tried to do.

That is the end of the report, sir.

Mr. FELDMAN. Now, Mr. Keller, the committee has before it a proposal which would use the NACA as a building block upon which to build a space agency. Have you had any contact with the NACA as such?

Mr. KELLER. No, sir, I have not.

Mr. FELDMAN. What kind of a man should head up an organization of this kind?

Mr. KELLER. I should think it would have to be a man that has got considerable ability and isn't too overimpressed with the briefings that he gets. I was always taught to buy with my eyes and not with my ears. And you can be led pretty far astray with a pretty plausible briefing.

Mr. FELDMAN. This is a new and far-reaching field, as you know.

Mr. KELLER. Yes, sir.

Mr. FELDMAN. And you in your experience were in pretty much that position when you undertook the program we just went into, that you just described?

Mr. KELLER. Well, sir, I think the nearest example to it, I would say, would be the Atlas, which was purely in the state of discussion at the time. Personally, I felt that we could not afford not to do some work on the Atlas. Yet, on the other hand, I thought it would be exceedingly extravagant to crowd it before we had completely studied the thing from both the standpoint of those who were highly favorable to it and those who felt there might be some trouble with it.

Now, there are some scientists that haven't been too enthusiastic about this shooting the moon. And there are others who have been very enthusiastic about it. And those who have been very enthusiastic about it, since it is sort of a popular subject today and one that seems to get money, have been quite vocal. And I suppose you are going to have quite a time getting those who are not to come out and speak against it.

I am looking, sir, for a report that I had. We took the prospectus on the Atlas job. And that is what I got Dr. McMath in for. I asked him to go through them. It took quite a while. Sir, there was a wheelbarrow load of studies. And after he went through those studies, he came back and said that what these studies say is that if we can do this and this and this, we think the missile will be a success. And then later—and I don't have that letter—at least I can't locate it—he had one of his men from the University of Michigan go into this in greater detail. And he recommended that more time and study be put on the matter of how they were going to get the missile on its

guidance track and how they were going to get reentry of the warhead, feeling that those things could be explored from a laboratory standpoint rather than by building a half-scale model.

And we gave great encouragement to some real straight laboratory work in both guidance and reentry.

I think considerable has been done on that. While it may apparently appear to some people that it delayed the program, I think it has advanced the program, because you know what you are going to have to deal with.

Mr. FEDLDMAN. Well, now, could you indicate to us the kind of a man that should head up an important agency of this kind that is going to be permanent in nature and is going to have this vast undertaking of peacetime development of satellites and space exploration?

Mr. KELLER. I think in the first place he should be a man that isn't interested in promoting any of his own ideas. I think he should be a man that should be perfectly free to buy that which he believes in and not to promote something that he is intrigued with.

Mr. FELDMAN. Well, if a man has had no experience in the building of hardware himself, but has acted merely as head of a service agency, would you say he is qualified to head such an agency?

Mr. KELLER. Well now, you are getting into a pretty difficult area. I don't know how to type people by types. All my life I have selected people by my experience with them and having the deep conviction that the man was suited for the job.

I have watched young men coming along, and when I felt they were particularly good, I usually maneuvered them out of the position they were in into another one, so I could find out whether they were moving with the pack or whether they had the initiative and the ability themselves.

That is a great way to find out. I know the Government cannot go through all of those things. I wouldn't want to be put in the position of trying to pick the man for that job. I think it is a very difficult job. But I do feel this: That if the outer space is important, it should be of greatest importance to our armed services. If it isn't of importance to our armed services, I don't think that the armed services should be deprived of things they need in order to carry on the outer space concept. It is going to take quite a time to determine what the useful things are. But if you don't do some work on it, you will never find out.

Mr. FELDMAN. Are you acquainted with the Jupiter, by the way?

Mr. KELLER. Yes, sir; I know something about the Jupiter.

Mr. FELDMAN. Was that developed at the Ballistic Missiles Arsenal?

Mr. KELLER. That is a ballistics missile. It has had its conception at Redstone under Dr. Werner van Braun, whom I know quite well and respect quite highly.

Mr. FELDMAN. Were any of the same principles in hardware used at Redstone and adapted to Jupiter?

Mr. KELLER. Yes, sir. The principles, in particular.

Mr. FELDMAN. Was the component reliability testing at Redstone directly applicable to Jupiter?

Mr. KELLER. Yes, sir.

Mr. FELDMAN. In the arsenal system of development used by the Army, a missile is developed and the test missiles are made at the arsenal.

Simultaneously, the contractor completes his production engineering work in cooperation with the arsenal, completes his production facility, and it is in production by the time the research and development program is completed. How does this compare in terms of time, money, quantity, and quality with the other system where a contractor produces the test missiles on the final production line and must modify this line and all the missiles he has produced with each change directed by the test firings?

Mr. KELLER. Well, sir, somebody has said it is much harder to make a correct decision than it is to make a decision. And when you get into this testing phase, the missile itself will tell you when you are right and when you are wrong. And your problem is to find out what the missile is telling you.

Now, there are three phases to any missile development. They are propulsion, aerodynamics, and guidance. Propulsion is usually something that is selected from component testing and from the development of fuels.

If you are going to develop a missile, you go over what are the fuels that are available to you. And you know something about the mechanism that is going to be used to handle those fuels; when they are solid, you know considerably about their characteristics and their peculiarities; if they are fluid, you know something about your problems of tankage and pumping; and burning.

Quite often a fuel, particularly a solid fuel, that has been developed for rather small size, doesn't necessarily translate itself into large size and large thrusts without introducing many, many treacherous complications.

So you may have a specific output fuel that has been laboratory tested on a small scale that cannot be immediately put into a large caliber use without bringing in a lot of complications due to making it in large diameters, long lengths, and getting the uniform burning over a much longer period of time.

And that very often bothers the development of a missile.

So that it seems that the history of the thing were that it took about 3 years to develop the thrust and the aerodynamics before you got into your guidance.

Now, there have been built in the last 5 or 6 years some very excellent static testing equipment in this country for testing fuels clear up to full size.

I think the time has to be taken to prove out the burning of this fuel and get its peculiarities and its characteristics and get it stabilized before you begin to commit any guidance to it.

For what I have read of the tests of some of our rockets, a great many of our failures have been due to a failure of propulsion in the first stage. To me one 1,500-mile missile hasn't performed very well. It hasn't completed its first stage of flight. To me that is still just testing propulsion and hasn't anything to do with the complete missile. And the aerodynamics are getting to be better and better known.

There are slight improvements that come along. But we cannot very well commit guidance to a missile that is having trouble with propulsion. It isn't, I think, good to do it; because you complicate the firing, and you put an awful lot of expense into it in putting the guidance in.

So that I think one of the real problems is trying to crowd these things a little too fast sometimes. Sometimes you get a race on, not only between services, but perhaps between contractors that can cost considerable money. And I think the thing has got to be closely handled, yet you have got to be friendly to it. But I think you have got to listen pretty closely to the people who are doing the job.

I always found that you found out more about these problems when you got in the physical presence of them. They have a habit of clearing themselves up when you get in their physical presence and you get to the people who know the intimate detail of what they are working with. These reports that come on up and up, the higher up they get the less what I call germane information is there for you to help you make a decision. That is why we went out in the field most of the time and talked to the people that were doing the work and in the presence of the missiles.

Maybe that is a long, involved statement.

Mr. FELDMAN. It isn't at all.

That is all, Mr. Chairman.

The CHAIRMAN. Mr. Natcher.

Mr. NATCHER. Mr. Keller, as you know, the bill before the committee, if approved and enacted into law, will provide for research into problems of flight within and outside the earth's atmosphere.

Mr. KELLER. Yes, sir.

Mr. NATCHER. This particular space agency would take over the functions and duties of the NACA. The NACA, Mr. Keller, as you know, is an organization with some 7,600 employees, controlling some $500 million worth of property which is used by the NACA.

Now, as a successful businessman, with your experience in the Government, above all as an outstanding American, Mr. Keller, how do you feel about a program, insofar as outer space research is concerned and our missile program at the present time?

As you well know, at the close of World War II we became very complacent. Our people were much concerned at that time because we were behind. Then Russia developed an excellent jetplane, the MIG–15. They were successfully operating it in Korea. Then we were suddenly startled, as you know, Mr. Keller, to find out that the Soviet Union had placed two satellites in orbit, one over 1,100 pounds.

Now, we have placed three in orbit. And I am just wondering if our people aren't now just a little complacent about it all.

How do you feel, Mr. Keller, about this—the overall program as far as research into outer space?

Our present missile program, should it be a crash program or what should we do?

Mr. KELLER. Well, first let me answer the last part of your question.

My personal opinion of the dither that went through this country with the launching of Sputnik was occasioned by our chagrin. We had been very busy telling the people of the United States how much better we were than the Russians. And I think we were quite chagrined to find they had put a missile into space. If you lick a kid in the alley, you are still his friend unless you go around and tell all the other boys that you licked him and then he is laying to get back at you.

Inasmuch as we are in a geophysical exploration and we are going to give our results to the world for scientific benefit, my personal feeling was—I am glad that the Russians got the missile up and that now maybe we will stop reaching for the moon and use some of the facilities that we have and the equipment we have to put one up which we finally did.

I believe that anything that is on such a high scientific plane as this is never by itself free completely from that which you have done before. The experiences you have had can help and often leads to new things.

And most of this experience is in the services, sir. And I think that regardless of what you do outside of the services, that the services are going to be thinking of practical uses for the defense of this country that they will want to use outer space for.

And I further want to say that I think we have just as fine administrators and men in the services as we have outside of the services. They come from the same kind of homes. They go to our academies, where they get perhaps the best training as Americans. They are sent to other schools beyond that. And I have never failed to find very excellent people.

I think if we did more to put the responsibilities up to the services, that they would handle them better.

The CHAIRMAN. I take it then, you are satisfied?

Mr. KELLER. I am satisfied?

The CHAIRMAN. Yes

Mr. KELLER. I am never satisfied, sir. But there drifted across my desk the other day a pamphlet from Nation's Business. It says: "How to avoid management's 7 deadly sins."

Among them are listed "pride, laziness, anger, unchastity, greed, and gloominess."

I read that article with a great deal of interest, because it is not an article as a basis for criticism of those above you, but rather an article for introspection and self-analysis of your own attitude and character.

But there was a thing in that article at the close that struck me very forcibly. And it put into words better than I ever could the things I have always felt And I have been carrying it in my pocket ever since

I didn't think I would use it here today, but this was said:

> If the feeling of belonging is built up, it can counteract and minimize the tendency of faults to develop. You cannot remake your employees, but you can help develop potentialities. Ideas and execution are seldom found in the same head. But a team operation utilizing strengths to offset weaknesses can minimize shortcomings.

I think that is a very profound thing. I commend the whole article to you. And I believe that in building up any kind of an organization, you have got to have the ideas; you have got to have the administration.

Mr. NATCHER. Mr. Keller, let me ask you this question. As far as our present missile program and our research insofar as outer space are concerned, we have had witnesses appear during the last 2 weeks who have positively stated to this committee that under no circumstances were they in favor of a crash program. And they gave fine reasons why we should not have this type of program.

Are you satisfied, Mr. Keller, with the present rate we are proceeding at?

Should we have a crash program?

Mr. KELLER. I think we are trying to proceed too fast, sir.

Mr. NATCHER. That was the question I had in mind.

Mr. KELLER. I think we have tried to put missiles or satellites into orbit with propulsion foundations that haven't proven themselves.

Mr. NATCHER. As far as our missile program generally is concerned, you believe that we have attempted to proceed too fast, probably based upon what the Soviet Union is doing?

Mr. KELLER. I think we have gotten into the spirit, we might say, of envy. And I think that is a pretty bad thing to get in anybody's mind.

The CHAIRMAN. Does that include the intercontinental ballistics missile?

Mr. KELLER. I think that—well, we haven't fired any intercontinental ballistics missiles——

The CHAIRMAN. I say, in answer to this question.

Mr. KELLER. We are going too fast—yes; we are going too fast in our getting—in our effort to get our bugs cleaned up. I don't think you should have practically 4 succeeding tests of 1 missile in which its propulsion fails.

Mr. NATCHER. Let me ask you this. As far as research into outer space is concerned, do you believe that we should proceed at a more rapid rate, keeping in mind the future of satellites, what they might do, and so forth, and the uses for which they might be made? Are we proceeding fast enough in this particular program?

Mr. KELLER. I don't think so, but you have got to have the ability to lift it up there, to put it into orbit.

And we are putting it up with equipment which we had, which we had under development, some of it more completely developed than the rest, but some of it is still in trouble.

Now, without naming it, your best one today has just recently run into some ball-bearing trouble. And I think that the testing should be held up until static testing has proven that that ball-bearing trouble has been completely licked before you go to work and fire away a million-dollar gadget and a lot of fuel.

Mr. NATCHER. Mr. Keller, I want to thank you for your appearance before our committee.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. O'Brien.

Mr. O'BRIEN. I agree you should not rush into anything just to accomplish anything spectacular; that we should move cautiously.

But isn't it an admitted fact that the Russians are substantially ahead of us in the propulsion field?

It took 250,000- or 350,000-pound thrusts to get Sputnik up there. The best we have done is between 40,000 and 83,000.

Mr. KELLER. No, we have much more than that, sir. I think the Redstone motor is in the nature of 140.

Mr. FELDMAN. No; 83,000. The Jupiter is 83,000 and the Vanguard is 40,000.

Mr. KELLER. I thought the North American motor was in the nature of 125,000 and specific fuels had brought it up some.

Mr. KEATING. That is what I thought.

Mr. FELDMAN. 83,000 for the Jupiter.

Mr. KELLER. But the information seems to be quite current that the Russians have motors of larger thrust than we have.

Mr. O'BRIEN. That would hardly be a spectacular achievement. That would be a very substantial achievement which could have rather sinister implications unless we catch up in that field.

Mr. KELLER. I think they have been trying to accomplish that by multiple installations.

Mr. O'BRIEN. That I don't know.

Mr. KELLER. Yes, I think so. Of course, when you get multiple installations that is like getting every man on the team to pull his oar with the same strength.

Mr. O'BRIEN. I am perfectly willing to concede that if we put the same emphasis into this field and the same amount of our energy and wealth that we probably would be there, too.

Mr. KELLER. I think that our objectives have been entirely different, sir. I think our objectives have not been to be spectacular in front of the world. I think our objectives have been very realistic. I would be against developing a higher thrust motor just for the sake of outdoing the Russians and putting up a bigger satellite, sir.

The CHAIRMAN. Of course, nobody proposes that. There has been no evidence of such a proposal just for that purpose.

Mr. KELLER. I don't know of any. But I am saying that would be my position. I think that anything that we want to use in connection with our defense activities can be applied to satellite work. It is perfectly all right to do it.

I think we would be lax if we didn't explore satellite stuff when we have hardware and equipment that we can accomplish something with. But I wouldn't create it just for the sake of getting a satellite up.

Mr. O'BRIEN. Thank you, Mr. Chairman.

The CHAIRMAN. But you would, if the satellite would produce information of value to us from a military angle, or for other purposes.

Mr. KELLER. Yes. We can—we don't know what that information is going to be or just how it is going to work. And I am wondering if there isn't some way to prove out the effectiveness of the collection and transmitting of the information without necessarily putting it in a satellite.

Mr. FELDMAN. The scientists seem to feel, of course, that it can't be done nearly as well any other way except that way.

Mr. KELLER. There are certain things I imagine thay can not do anyway except that way. But, we have also got an immediate problem ahead of us. But scientists—and I don't blame them for it—they work at their trade—their business is to advance science, and it is natural they should and if they can get the money I don't blame them for asking for it.

And if I was a scientist, and I wanted to make some exploration and could get the money for it, I would go after it. But we have got to determine here—what we have to determine is somewhat where we put our money, too, you see. Are we going to put it in defense, or are we going to put it in scientific exploration?

When they talk about the condition of the world, Russia vis-a-vis the United States, in one breath you think they (the Russians) are breathing down our neck and they are going to be over here tomorrow,

and I am quite sure no satellite is going to be ready in the next 10 years with conclusive ability to protect us—I think we have to weigh that.

The CHAIRMAN. What about a continental ballistics missile? According to the testimony we have, they are a year and a half or 2 years in advance of us in that field. Don't you think that is a matter of great importance for our country?

Mr. KELLER. Yes, I do, but I think the most wonderful thing that could happen to the world is if you drove a stake in the South Pole and let everybody take a shot at it and see how close they come to it.

The CHAIRMAN. You can do that, of course. We all have theories. We have just got to get back to the practical world again.

Do you sit there with a feeling of security in the knowledge that the Soviet Union, according to the best evidence publicly available—not classified—is a year and a half to two years ahead of us in the field of intercontinental ballistics missiles?

Mr. KELLER. No, I don't feel that way, sir.

The CHAIRMAN. I am not talking about satellites, I am talking about intercontinental ballistics missiles.

Mr. KELLER. I am talking about what we call roughly the 5,000-mile missile.

The CHAIRMAN. The evidence we have is that the propulsion power, the thrust, to send an 1,100-pound Soviet satellite into the air is sufficient propulsion to hurl an intercontinental ballistics missile 5,000 or 5,500 miles.

Mr. KELLER. With what payload?

The CHAIRMAN. Well, the evidence is they can do it. The question is whether it is perfected. That is the question. The reentry and other factors are also involved.

Mr. KELLER. And terminal accuracy.

The CHAIRMAN. Exploration has to be done to determine what bugs exist. It could be improved upon.

Mr. KELLER. Yes, sir.

The CHAIRMAN. They tell me—I don't know how true it is—you know more about that than I do—that the most difficult task is to overcome the propulsion difficulties. After that they can overcome difficulties——

Mr. KELLER. Well, they are the most difficult as long as you have them. But I have also found after they have been licked sometimes those guidance difficulties become very important.

The CHAIRMAN. That is true. But you can't get to the guidance unless you overcome the propulsion.

Mr. KELLER. I tried to bring that out. That is the first thing you have got to develop.

We are not developing, that I know of, any higher specific thrust engines than we now have so far as physical size is concerned. If there is, I do not know anything about it. There may be. But there is no question but that the Russians did put up a sputnik of considerable weight. And I think our scientists can very easily figure the amount of thrust they had to have to do it.

And I do not think that our boys have figured out just how they can make that combination now with existing hardware at this time. Whether they can do it by more multiplication of engines is another thing.

I think that is a matter of time. But I do not think that you can consider this matter of thrust without also considering the tremendous progress that has been made in the warhead of destruction.

For instance, in 1951 we laid down the Redstone missile, because the only bomb that we had at that time proven that would be worth committing to a missile so far as its terminal accuracy was concerned would weigh in the nature of 6,000 pounds.

Well, the work that the Atomic Energy Commission has done in reducing the size and weight and the effective area of destruction its bombs have has been so phenomenal that it has opened up a whole new field of possibilities. Because the lighter your load, the more distance you can cover. And I think that the Atomic Energy Commission should be given a great deal of credit for making our intercontinental ballistics missile possible.

The CHAIRMAN. Well, is it possible?

Mr. KELLER. Yes, I think it is possible.

The CHAIRMAN. I mean, have we perfected it? Of course, it is possible. But we are a year and a half or two years behind the Soviets.

Mr. KELLER. I don't know. I think it has been in the papers that the Army flew one for over 3,000 miles and recovered its warhead. And they did that pretty near a year ago. And I think that tells you quite a bit, doesn't it?

The CHAIRMAN. Well, I would rather get your testimony as to whether you are satisfied with the progress made.

Mr. KELLER. I am never satisfied.

But I want to say this. I think we have made very significant progress. And I am confident that our intercontinental ballistics missiles will be operating and operating successfully.

I cannot put a time limit on it.

The CHAIRMAN. Well, of course, we all agree with you on that. But I would like to have it operating successfully at least before, or not later than, the Soviets operate successfully. Wouldn't you?

Mr. KELLER. Well, the only thing you have told me is——

The CHAIRMAN. Well, wouldn't you?

Mr. KELLER. Why, certainly.

But the only thing that I know about the Soviets is that they have enough thrust to put a sputnik of large size into orbit, larger than we have put into orbit.

The CHAIRMAN. And you attach no significance to that fact?

Mr. KELLER. The only significance I attach to that is that the Russians have developed rockets with more thrust than we have.

The CHAIRMAN. Well, what results might flow from that?

Mr. KELLER. The result that might flow from that is that we do not know how many they have fired. They have put up two. We don't know what their guidance is.

The CHAIRMAN. I mean in terms of other things—intercontinental ballistic missiles—does that have any meaning to you?

Mr. KELLER Well, you still have to have guidance on them.

The CHAIRMAN. I know. But in terms of propulsion of intercontinental ballistics missiles.

We all understand there is a guidance problem and a reentry problem. We are pretty well educated in that.

Mr. KELLER. I know you are.

The CHAIRMAN. But if a nation is a year and a half ahead of another nation, it is reasonable to assume that unless some acceleration is made by the second nation, that the first nation is going to perfect those things before the second nation. Isn't that reasonable to assume?

Mr. KELLER. You can assume those things; yes.

The CHAIRMAN. Certainly.

And in connection with that, they are ahead of us in the intermediate field. You know that, don't you?

Mr. KELLER. No; I didn't.

The CHAIRMAN. Well, if they perfect the intercontinental ballistics missile before we do and at the same time perfect a pretty good defense against our intercontinental bombers, which is our main deterrent? I don't like the word "deterrent." I am not for this idea that we won't attack under any conditions. I think the law of necessity might sometimes compel us to do so.

But we are tied up with that, anyway, in national policy. And if they perfect the intercontinental ballistics missile to the point where it is 85 or 90 percent accurate, that is pretty good accuracy. If, at the same time, they perfect a good defense against our intercontinental bombers, then our deterrent or retaliatory power is pretty well nullified; isn't it?

Now, don't those things happen?

Mr. KELLER. Well, this is the great difficulty I have. All the things are put up on "if's" and assumptions. And most of my life has been trying to give weight to those "if's" and assumptions.

I cannot take all of those "if's" as realities. However, your assumptions are justified and I think this matter of thrust is of great importance to our country.

The CHAIRMAN. Well, we have had testimony from the military, and we have had evidence from others. And those things are not beyond the realm of reasonable probability.

Mr. KELLER. I cannot help what others think, sir. I think for myself. But I have had these pressure things put on me, too, when I was running this guided missiles thing, you see.

But I didn't always buy them. Now, there is a great deal going on in our missiles field. I've seen test stands able to handle much more thrust of static firing of propulsion units. I am not familiar with the programs or progress of larger thrust rockets. And you know we might even get something that will intercept their ballistics missiles.

The CHAIRMAN. That is true.

Mr. KELLER. And I would not wash out the Snark. I can understand that you say, "Well, it is really not a Derby horse."

The CHAIRMAN. Well, how fast does Snark go?

Mr. KELLER. It is subsonic; about the speed of sound.

Mr. FULTON. 0.9 of sound.

It is about 10 percent below the speed of sound; isn't it?

Mr. KELLER. I think the Rascal can be a pretty effective missile, too.

The CHAIRMAN. What is the speed of the Snark?

Mr. KELLER. Mach 0.9.

Mr. FELDMAN. This one goes about 20 times as fast?

Mr. KELLER. Yes; sure.

The CHAIRMAN. How many miles an hour does Snark go?

Mr. KELLER. Mach 0.9 speed of sound.

The CHAIRMAN. How about miles per hour?

Mr. KELLER. That depends on our altitude.

Mr. FELDMAN. 650 miles?

Mr. KELLER. Say 650; yes.

The CHAIRMAN. Do you think that is an effective weapon?

Mr. KELLER. I think it can be.

The CHAIRMAN. Do you think it is the answer?

Mr. KELLER. I think we would be silly to stop there.

The CHAIRMAN. Do you think——

Mr. KELLER. But I wouldn't wash it out.

The CHAIRMAN. I am not talking about washing it out. I don't say it doesn't belong in the arsenal. But I am talking about intercontinental ballistics missiles.

If the Soviets perfect one that can go several thousand miles an hour——

Mr. KELLER. I don't think our ability to make war and win war should be based completely on the enemy's weapons. I think we should give a good bit of weight to our own.

The CHAIRMAN. I agree with you on that. On the other hand, however——

Mr. KELLER. From the psychological standpoint, though——

The CHAIRMAN. Permit me to finish.

I said I agree with you on that. But there is the law of relativity. We can be strong militarily as against Liberia, let us say, but we might be weak against some other particular nation in some respects, important respects; wouldn't we?

Mr. KELLER. I will answer it this way: If we want to make a big impression on the rest of the world, I would sooner have the thrust that the Russians have than to have them have it.

I think that is what you are getting at.

The CHAIRMAN. I will let you know what I am getting at. I believe that if we are going to err, we had better err on the side of strength and not on the side of weakness.

We had better err on the side of security and not uncertainty and insecurity.

Mr. KELLER. I wouldn't disagree with that.

The CHAIRMAN. We wouldn't have any business or anything else if we didn't have the country we have.

And, above all, we have got to preserve our form of government. That is the first thing. And when I hear people talking about coupling this and that, I sometimes wonder just what they mean.

The important thing, after all, is not to waste money. But, on the other hand, if we are going to err, we had better err on the side of progress and strength.

Mr. KELLER. I would not disagree with you one iota on that. But just having somebody make a statement that they are going to do something doesn't mean they are going to do it.

The CHAIRMAN. That is true.

Mr. KELLER. And there is a time when decisions have to be made to go forward and I think this time is here.

The CHAIRMAN. Well, that is why Mr. Feldman asked you the type of man you felt should head up this administration.

Mr. KELLER. Yes.

The CHAIRMAN. I would like, when you edit your remarks, for you to go into it more thoroughly, because you have given some partial answers. I think you might want to elaborate on that.

Mr. KELLER. I think I wouldn't do it with one man.

The CHAIRMAN. Are there any further questions?

Mr. O'Brien.

Mr. O'BRIEN. I would like to explore this a little further.

I think we are all agreed that we do not want to pour tremendous amounts of money into spectaculars.

Mr. KELLER. I agree on that.

Mr. O'BRIEN. I have no desire to send a man to the moon, just to say we did it and the Russians didn't. But isn't it a fact that their concentration on these spectaculars, as we might call it, has outmoded many of the weapons and things upon which we have spent billions and billions of dollars? Isn't it a fact that unless we press forward into the spectacular field, if you wish, that we may very well find that what we are doing now is outmoded tomorrow?

We have got to leapfrog in this field.

Mr. KELLER. I think that has been the history of arms. They have been outmoded. As we have gone along, they have been outmoded.

But, you know, after Hiroshima, we had the feeling there would never be another war. But we forgot that the thing had to be delivered.

The CHAIRMAN. Forgot what?

Mr. KELLER. We forgot that the bomb had to be delivered. And we did wake up to it, though, and went to work on it.

And I think that our services are going to whip this problem and do a spectacular job of it.

I cannot give you the timetable. But I do believe that appointing heads and pressuring this thing around isn't going to do the work.

The work is going to be done down on the hard-work bench. And I am more interested in the people down on the hard-work bench that are doing this job than I am in the guy that is supposed to be heading it up.

The CHAIRMAN. Well, they can't do it unless top management is capable of making the right decision and does make it.

Mr. KELLER. You don't want him alone. You want to surround him with the best advice that you can get and the most practical approach. And I think that you will find a great deal of that; and most of it is in the uniformed services. Because these are people who are going to have to go out and fight these battles. These civilian heads are not going to fight them.

Those uniformed servicemen are interested in their tools. They are perhaps more interested in their tools than anybody else.

The CHAIRMAN. Nobody will argue with you on that, Mr. Keller.

Mr. KELLER. I feel they have the capability.

The CHAIRMAN. But you will admit that in our top management in the military in the past, not so much today, there has been a lack of coordination.

Mr. KELLER. I am awfully glad to hear you say that, coordination, because I think the best thing to be done for the services is to wipe out this word "unification."

There are so many facets to military work that unification and the policy guy who heads the outfit is not necessarily going to make the right decision every time.

It is a matter of how you are going to get coordination between the services because even in each one of the branches you have just as many things to coordinate as you have between the services.

I think the whole heart of this thing goes right back to that statement, how to have them feel that they belong. I feel they are human beings just the same as the rest of us and if you give them somebody to make their decisions for them so they are going to avoid making them, they are going to pass it on to him. If he makes a bad one, it is his fault.

I think if these military people were handled from the standpoint of "We want coordination from you," and you put it on their back, they have the capability of measuring up to it and doing it.

The CHAIRMAN. Are you through, Mr. O'Brien.

Mr. O'BRIEN. Yes.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. I reserve my time at this point, and first yield as a courtesy to the gentleman from New York, Mr. Keating, in order to alternate the order of questioning on this side.

The CHAIRMAN. Mr. Keating.

Mr. KEATING. I have one line of inquiry, Mr. Keller.

I want to read you a very important sentence from this proposed bill which seems to be the subject of great controversy, both as to what it means and as to what the result means:

> The Congress further declares that such activities—

meaning space activities—

> should be directed by a civilian agency exercising control over aeronautical and space research sponsored by the United States except insofar as such activities may be peculiar to, or primarily associated with, weapons systems or military operations, in which case the Agency may act, in cooperation with or on behalf of the Department of Defense.

Now, the assertion is being widely made in some quarters that this bill is not a bill to place the space exploration in the hands of a civilian agency at all, but is one which indicates that this whole project will be under the sponsorship of Defense.

Now, my own feeling is that if we need to make any changes at all, we need to strengthen the Department of Defense end of it. I favor the civilian agency, but I think that this criticism is ill founded and that the Department of Defense should have greater authority than they have under the terms of this bill.

Now, let me ask you this: So far as you know, all of the space exploration to date has been handled by the military. Is that not right?

Mr. KELLER No, I don't believe so. Isn't Dr. Porter in charge of it?

Mr. KEATING. I mean by the Department of Defense.

Mr. KELLER. Yes.

Mr. KEATING. Both military and civilian in the Department of Defense.

Now, No. 1, you favor the creation of a civilian agency?

Mr. KELLER. You know, it is very hard for me to figure out how words will do a job. And I do not know how to tell you how to set up a civilian agency that will give the military what they need.

Mr. KEATING. You gave one answer to a question which I think I caught correctly, and, if I did, I think we should pursue that.

I believe you said you would not put this under one man. Is that right?

Mr. KELLER. That is right.

Mr. KEATING. Whom would you put it under?

Mr. KELLER. I would form a little board for this thing, and I would form them on the basis——

Mr. FELDMAN. How many?

Mr. KELLER. At least three. I would put them on the basis that they had nothing else to do but that.

Mr. KEATING. Three full-time men?

Mr. KELLER. Three full-time men; and I would take two of them out of the services.

Mr. KEATING. You would have a 3-man board with 2 out of the services?

Mr. KELLER. Yes, sir.

Mr. KEATING. That would rather destroy the character of this as a civilian agency, would it not?

Mr. KELLER. I don't know anything about that. I am not an expert on Government. I am just a mechanic and trying to get things done by the people who do them.

Mr. KEATING. That is not your own concern at all, and we appreciate your being here and you have been very helpful.

Mr. KELLER. My concern is as a citizen.

Mr. KEATING. This bill calls for a single director with an advisory board of 17 members. The director has the authority, but this advisory board is, let us say, advisory-plus. There is a peculiar wrinkle that there are certain things that he must talk to them about before he moves, but he does not have to take their advice. It is a rather unusual arrangement.

Now, would you think that was cumbersome?

Mr. KELLER. I have never been able to do anything with a group of 17. I had a little experience a few years ago.

The mayor of Detroit made me chairman of a committee to lay out what we called the cultural center of the city on a 50-year development and presented me with a committee of 31 people. We had one meeting of the committee and I got them to O. K. an executive group of 4 and we proceeded to lay out the city and after we had it laid out we called the 31 together and we presented a mockup. They liked it and we O. K.'d it. We took it down to the mayor and he liked it and it became part of the city's program.

I think we would be talking yet if we had 31 all doing the study work, because my experience, when you get a committee of that size, is that unless you have something specific for each one of them to do, you get about in the position of the fellow that had the large board of directors and said to one of his directors, "What do you think about this?"

He said, "How do I know what I think until I hear what I say?"

Mr. KEATING. I want to say to you, Mr. Keller, that your suggestion of a three-man board with two from the military is novel. We have not heard that before.

Mr. KELLER. I am glad I came up with something unique.

Mr. KEATING. And we are glad to have you here.

Thank you. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. We are glad to have you here. We feel your remarks have been straightforward and you certainly have made your position clear.

Do you think that a board of seven as a commission with, say, three of them from the military services, and with General Doolittle as the chairman, would be a fair type of commission?

Mr. KELLER. I had one experience that I think I should tell you about. I headed up the committee that made the last study on the Maritime Commission, which was composed of a board, I believe, of six, if I remember rightly. When you set these boards up you think they are going to go on a broad policy basis and you are going to get the effect of a lot of brains.

But I am the fellow who headed the committee whose report was taken verbatim by Hoover and resulted in the change in the Maritime Commission.

The reason we arrived at that decision, and we had a group of five on the committee that made the study, was because we found the Commission became an operating commission instead of a policy commission.

They divided the different functions in maritime work among each one and then they would vote.

Of course, they would support the fellow that had the proposition, we will say, on docks and ships and the one that had the one on subsidies. He was the king on those items.

Well, people like to administer. You get a big board and they will split their functions up, you see, and you won't have that detached, independent consideration of all the phases of the thing by the group.

Do I make myself plain.

Mr. FELDMAN. Does a big board lend itself to logrolling?

Mr. KELLER. A big board lends itself to logrolling.

Mr. FELDMAN. I ask that because Dr. Hagen in his testimony before this committee indicated that could happen. He was worried about that fact.

Mr. KELLER. Actually, in the words of Jules Bache, who was a wise old gentleman and happened to be on our board of directors, "The function of a board of directors is to select management; a board is too big to manage and they should select management."

The CHAIRMAN. You were replying, Mr. Keller, to a question about a commission with each man having an operating power or a disivion.

Mr. KELLER. I am in favor of a small group that sets the policies.

Mr. FULTON. That is all. Thank you very much.

The CHAIRMAN. If there are no questions, thank you very much, Mr. Keller. We have enjoyed your appearance before us. We appreciate your testimony.

Mr. KELLER. Thank you.

Mr. NATCHER. Could I make one observation at this point in the record?

I want to thank our counsel and members of the staff. They have done a fine job, a job that has required a lot of patience and a lot of time.

I think Mr. Feldman and the staff should be commended.

Mr. FULTON. I second the motion from the Republican side.

The CHAIRMAN. I think that is the unanimous viewpoint of all the members of the select committee.

We are very fortunate in having Mr. Feldman and the other members of the staff. They have done a remarkable job.

They selected the witnesses. The Chair had nothing to do with it. I delegated authority to them and they have done a remarkable job. I am glad to have the public record show that fact.

Mr. KEATING. I think, Mr. Chairman, if I could be recognized, that the record should also indicate the extreme fairness and courtesy which has attended the operation of the chairman. Every witness, every member of the committee, has been very courteously dealt with and I know all the members feel that way about it.

Mr. FULTON. And so far, in the committee there has been an absence of partisanship.

The CHAIRMAN. I might say that no chairman had better or more dedicated members of the committee, select, standing, or otherwise, than I have had, and I appreciate it very much.

This concludes the public hearings and we will go into executive session next Tuesday at 10 o'clock in the committee's room.

Thank you very much.

The committee now stands adjourned.

(Thereupon, at 3:45 p. m., the public hearing was concluded.)

ASTRONAUTICS AND SPACE EXPLORATION

MONDAY, MAY 12, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS
AND SPACE EXPLORATION,
Washington, D. C.

EXECUTIVE SESSION

The committee met at 2 p. m., pursuant to notice, in room B-214, New House Office Building, Hon. Overton Brooks, presiding.

Present: Representatives McCormack (chairman), Brooks, Hays, O'Brien, Metcalf, Natcher, Sisk, Martin, Arends, McDonough, Fulton, Keating and Ford.

Present also: George J. Feldman, director and chief counsel.

Mr. BROOKS. The committee will come to order. The chairman, Mr. McCormack, is over at the Defense Department. He will be in any moment. He is delayed so it was suggested I take the chair temporarily. I know the purpose of the meeting today. Mr. Feldman has reviewed the testimony of the Senate and the House and there are certain things he wants to bring out which will take a little time, so I recognize Mr. Feldman, director and general counsel.

The chairman has gone over the same items that you are going over?

Mr. FELDMAN. Yes; but the chairman thought that we ought to have this meeting. There is an apparent difference between the testimony given previously before this committee and the Senate committee.

I would like to address these questions to Mr Johnson. When you testified before this committee, Mr. Johnson, we named a list of functions such as weather and communications and a million pounds thrust, and so on. We asked whether or not those functions would be military in character or would go to a civilian agency In response to those questions you indicated that the majority of them at least, in your opinion, were military in character and therefore belonged in the military. You also stated that ARPA and NACA were in the process of trying to determine whether the new NASA would have jurisdiction or would have control over those specific functions or that ARPA would have.

Could you tell us whether such a meeting has taken place?

STATEMENT OF HON. ROY JOHNSON, DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY; ACCOMPANIED BY REAR ADM. JOHN E. CLARK, DEPUTY ASSISTANT TO THE DIRECTOR; DR. HERBERT YORK, CHIEF SCIENTIST; AND ROBERT DECHERT, GENERAL COUNSEL, DEPARTMENT OF DEFENSE

Mr. JOHNSON. Yes, sir; there have been repeated meetings. I have here a document that has not been approved by Secretary McElroy, nor has it been approved formally by the National Advisory

Committee for Aeronautics, although it is now in form ready for the signatures of the two in answer to a request on the part of the President to review the two programs, to come up with a recommendation that was a joint one and to come up with funding recommendations. This document is complete in that we do have a general guide to be used for the identification of the space program.

We have the NACA or Space Agency, if it is created, fiscal year program spelled out over a period of several pages. We have the same positions for Advanced Research Projects Agency. We have the budget proposal for both agencies and a reconciliation of transfer funds.

I must point out that Dr. Dryden has not returned from Europe—may be back now—has not personally approved it but the three members of his staff who were assigned to work with us have approved it. I briefly discussed this with Secretary McElroy this morning. I think he is in agreement with this. I am quite sure, in my own personal opinion, that when the National Advisory Committee for Aeronautics meets on the 15th that they will approve this.

So to answer your question, therefore, this has been accomplished to our satisfaction.

Mr. FELDMAN. This program, I take it, is hypothecated on the assumption that there will be a new NASA?

Mr. JOHNSON. That is right.

Mr. FELDMAN. And only to be effective if and when adopted?

Mr. JOHNSON. That is right, sir.

Mr. FELDMAN. Over what period did these meetings take place?

Mr. JOHNSON. These meetings started promptly after we received the President's letter asking us to engage in this work. I would have to refer to my files to give you an exact date but it was shortly after the President submitted his message to the House of Representatives. This is dated April 2. My recollection would be that these meetings began within the week following April 2.

Mr. FELDMAN. On April 2, about 7 o'clock in the evening, after Congress recessed, we received a copy of the President's legislative proposal. Between that time and the time that you appeared before this committee did you see that bill?

Mr. JOHNSON. We in the Department of Defense had a period allocated to comment on the bill. We in ARPA did comment. So did other parts of the Department of Defense. I believe a consolidated statement was forwarded. I asked Mr. Dechert to appear here today. If you wanted to refer that question to him he could answer it for the Department of Defense.

Mr. FELDMAN. Your answer, incidentally is not responsive to the question. I am not talking about the bill before it was sent up to the House or to Congress. I am talking about the bill between the time it was sent up to Congress, which was 7 o'clock on April 2, and the time you appeared before the committee after it was completed. Did you look at the bill at all?

Mr. JOHNSON. Yes, sir.

Mr. FELDMAN. Did you raise any of the objections that you raised before this committee or make any suggested amendments the like of which you made before this committee when you appeared here, to anybody in the Defense Department or any other agency of the Government concerning the wording of the act, itself?

Mr. JOHNSON. Yes, sir. May I refer to Admiral Clark. We discussed the other day the document we received and commented on within the Department of Defense was language different than now printed.

Admiral CLARK. It was not in this form. I think Mr. Feldman is talking of the time after the bill reached the House.

Mr. FELDMAN. This is what I am getting at. The bill came to the House on April 2, after Congress had recessed. Congress did not reconvene until April 14. You did not testify until sometime after that date.

Mr. JOHNSON. Yes, sir. I understand your question now.

Mr. FELDMAN. Did you look at the bill during that period? Did you examine it?

Mr. JOHNSON. I did, sir.

Mr. FELDMAN. The language we are talking about was in the bill at that time, is that correct?

Mr. JOHNSON. Yes, sir.

Mr. FELDMAN. Did you make any comments or suggestions concerning that language to anyone?

Mr. JOHNSON. I did not recommend specific language within the Department of Defense but I discussed my interpretation and the interpretation of other of my associates which we conveyed to my superiors in the Department of Defense.

Mr. FELDMAN. With whom did you discuss the comments?

Mr. JOHNSON. Secretary Quarles.

Mr. FELDMAN. Specifically, what did you say to him in that connection?

Mr. JOHNSON. The language was too restrictive.

Mr. FELDMAN. Did he agree with you at that time?

Mr. JOHNSON. His interpretation of the language did not agree with mine, no sir

Mr. FELDMAN. At that time?

Mr. JOHNSON At that time.

Mr. McDONOUGH. Mr. Feldman, when you say restrictive you mean too restrictive as to which is military and which is civilian?

Mr. JOHNSON. That is right.

Mr. McDONOUGH. You follow it, George, but I think for the committee's benefit we ought to know what you two fellows are talking about.

Mr. FELDMAN. Did you do anything further about the bill at that time?

Mr. JOHNSON. No, sir. I discussed it with associates in the Department of Defense in an attempt to get every viewpoint on interpretation but I took no positive action other than discussion.

Mr. FELDMAN. Was the testimony you gave before this committee concerning the amendment to the bill of the same general nature of the comment you made to Secretary Quarles at that time?

Mr. JOHNSON. No, sir; I did not recommend any specific language to Secretary Quarles.

Mr. FELDMAN. The language in the exception on page 2 of the bill reads, "Insofar as activities may be peculiar to, or primarily associated with, weapons systems or military operations, in which case the agency may act in cooperation with, or on behalf of, the Department of Defense." Is that the only language in the bill you objected to?

Mr. JOHNSON. That is the only language I objected to.

Mr. FELDMAN. In your testimony before the Johnson committee did you say that if that language was corrected to meet your objections, that would answer your criticism of the bill?

Mr. JOHNSON. After my discussions with Secretary Quarles I did become concerned also with the language having to do with the constitution of the Board, the members from Government and the members from the Department of Defense; it was my intention in the hearings before the Johnson committee to also take exception to that language constituting the Board the number of representatives from the Department of Defense on the Board.

Mr. FELDMAN. In your testimony before this committee you indicated a viewpoint that that language should include more membership of the military on the Board, itself, is that not so?

Mr. JOHNSON. That is my understanding what I said, yes, sir.

Mr. FELDMAN. You did not make an observation of that kind before the Johnson committee, is that right? Or did you?

Mr. JOHNSON. I think there was some reference to that in the testimony. I think they made the statement and I think I did say I agreed in answer to a question.

Mr. FELDMAN. Now, it is our understanding that since you testified before this committee and the corresponding committee in the Senate you have checked the matter further in the Department of Defense, and your views now have official approval. Is that correct?

Mr. JOHNSON. That is correct, sir.

Mr. FELDMAN. In your opinion, is there any need for a civilian agency having a responsibility for research in the problems of flight in outer space?

Mr. JOHNSON. Yes, sir; there is definitely a need for a civilian agency.

Mr. FELDMAN In your testimony before the Senate committee did you not defer this question?

Mr. JOHNSON No, sir; I believe the question I deferred before the Senate committee was whether or not the NACA as now constituted, without any legislation, was adequate to carry on this job. That is the question, as I recall, I deferred an answer to but I repeated in my testimony before the Johnson committee that I was for a civilian agency, that the military could not do this on its own, it could not cover the whole field of science and technology that needed to be explored.

I urged a civilian committee be appointed I think there are 2 or 3 references to it in the testimony

Admiral CLARK. I think, Mr. Feldman, the question that was deferred is one that was worded sort of this way, "Why should there be a civilian agency?" and the idea of deferring was to submit those things which we thought a civilian agency might do, not whether it should be or should not be.

Mr. FELDMAN. Let me read the series of questions:

> Mr. WEISL Now in connection with the development of the ballistic missile for outer space you have had the cooperation of many civilian agencies. There is the radiation laboratory, there is the jet propulsion laboratory at Cal Tech and practically every leading university in the country cooperates with the Defense Department in research and development of the projects in outer space, does it not?
>
> Mr. JOHNSON. Yes, sir. I think this is one of the marvels of this present age. I am astonished at the amount of money voluntarily being spent by private

industry on purely speculation in space technology. We in our industry presentations have listened to 50 or 100 presentations on how to launch spaceships, how to get to Mars, how to get to the moon and so forth.

Mr. WEISL. I am talking about scientific experiments by civilian agencies at the expense of the Government of the United States.

Mr. JOHNSON. Yes, sir, we have had many such agencies.

Mr. WEISL. You had NACA working with you at Government expense?

Mr. JOHNSON. That is right.

Mr. WEISL. Now the reason that I ask this question is this. Why do we need another civilian agency to conduct research in outer space problems when we already have not only 50 research agencies doing this work but in addition have 200 or 300 scientific committees engaged in this work? The question I asked and it is only for the guidance of this committee, is why do we need another agency to do this limited experimenting in outer space when we already have these other agencies engaged in that work?

Mr. JOHNSON. Well, I think NACA has made very fine contributions in the field in which they have worked in improving the total aeronautical science. I believe that their present framework could extend their capability to improving methods in outer space. They have 7,500 employees, many of whom are outstandingly capable and I do believe if their charter were enlarged to special facilities to include outer space, that they would add to our total knowledge. We would have many more capable minds directed to this research.

Mr. WEISL. Well, we do not need legislation to enlarge the work of NACA. Could we not direct the NACA to engage in this work without creating a new agency. At least there you have a board where the majority decide the policy. Here you would have a board which would be the same board initially as the NACA, only that they would not have any vote. They would merely have the right to advise and recommend and be consulted with. Would it not be better to say to NACA, you go ahead and enlarge the scope of your work by conducting research on civilian peaceful uses of outer space without creating a new agency, with a new budget, with new rivalry again for power and jurisdiction? What is your answer?

Mr. JOHNSON. Now you really put me on the spot, sir. Could I defer the answer to that and give it to you in writing at a later date?

Mr. JOHNSON. Yes, sir, I understood. However, in other places in the testimony you will find that I do state we need a civilian agency in space technology.

This question here was directed, as I understood, whether or not we needed to create an agency outside of the NACA framework.

Mr. FELDMAN. I believe what it does say is that if the only thing we are going to do is enlarge the NACA, then why have a new agency? Is that what it boils down to?

Mr. JOHNSON. As I understand, the new agency would absorb the old agency. There would not be a new agency in the sense of another entity.

Mr. FELDMAN. That is not what this question is directed to at all. What he is saying is this, if we simply enlarge NACA you don't have to go to Congress for that, the President might do that by executive order or it might be done through an additional appropriation by the Bureau of the Budget.

Mr. JOHNSON. That is one way to do it, sir, yes, sir.

Mr. FELDMAN. And you would not need the new agency?

Mr. JOHNSON. If you follow that course, yes, sir.

Mr. FELDMAN. How about a space agency directed to the peaceful use of outer space?

Mr. JOHNSON. I believe it would be important in the instruction to the presently existing NACA, in the broadening of its charter, to give the additional authority to explore the science of space rather than to limit themselves to vehicles which the present NACA, as it was set up and as I understand in the language that set it up, did not have

quite the scientific connotation that I think the agency, whatever it should be, should be instructed to participate in. NACA has been primarily concerned with improving aircraft. I think there is a broader connotation required here which is to explore the science of space that would lead to improved transportation in space. To that degree the charter may be broadening.

Mr. FELDMAN. Would the request that you defer the answer to previous questions put to you by Mr. Weisl now be along the lines you have just indicated?

Mr. JOHNSON. Yes, sir. I have not finished the thinking through to answer the question but I do really believe that just to extend NACA would not assure us the peaceful civil scientific exploration that we need. I have gone back and examined the kind of work that NACA has been doing and if they continue to do the same thing but merely extend it to outer space it would be inadequate.

Mr. FELDMAN. Getting back to the previous question concerned with the fact that you were able to see the bill before April 2 and up to the time you testified before this committee, would you say that that would give you ample opportunity to make any suggestions in connection with it to the proper person in the Defense Department? Has that in turn been reconveyed to the people who are concerned with the drafting of this bill to make any corrections that they have?

Mr. JOHNSON. Frankly our problem in the Department of Defense I think was a matter of interpretation of language. As I stated before the Johnson committee, it was only in recent days that people within the Department of Defense became concerned by the language as I was. My discussion up to recent days did not have the impact that it has had recently.

I believe there was the feeling that this language allowed us to continue to work with NACA pretty much as it had in the past and there would be no substantive change.

Mr. FELDMAN. It has been stated, however, that this bill went through the Department of Defense very rapidly and you only had 24 hours to make your comments?

Mr. JOHNSON. That is correct, sir.

Mr. FELDMAN. Did you observe at that time this language in the bill?

Mr. JOHNSON I did, sir, and I so commented in a memo. I made my comments with regard to this controversial clause at that time when it was circulated to the person who was collecting the data who I believe also was a member of the Counsel's office.

Mr. FELDMAN Did you say that you did that by letter?

Mr. JOHNSON Yes.

Mr. FELDMAN. Do you have a copy of that letter here?

Mr. DECHERT I can cast some light on this question if you are willing to let me make a brief statement.

Mr BROOKS Will you make it, sir. We will appreciate it.

Mr. DECHERT I am Robert Dechert, General Counsel in the Department of Defense It is my responsibility to oversee the distribution of proposed pieces of legislation, whether they originate in the Department of Defense or outside, and to ask for comments. This bill has been in the hands of the Department of Defense ever since it was sent to the Congress. I think that the short time that Mr. Feldman mentions was the result of a sudden request we received

to have reports in on the bill, itself, very promptly because the Johnson committee was meeting. Up to that time the bill had been in our hands, but there was no specific request for report to the Congress because we did not know whether it was going to come up in this form or some other form. I ought to say there had been a preliminary discussion of this and there had been a preliminary report to the Bureau of the Budget signed by Mr. Quarles on April 1.

Mr. BROOKS. Do you have those here?

Mr. DECHERT. I don't have the reports themselves. I came rather quickly and gathered the files which were incomplete. The pressure of time, as I say, was pressure of time to get the formal comments in, because it was discovered that these comments would have to be in time for the meeting of the Johnson committee.

As Mr. Roy Johnson indicated, the bill had been available to us, just as you, Mr. Feldman, indicated it was available to Congress.

Mr. FELDMAN. To carry that through further, Mr. Johnson, the witness before this committee was able to see it for that short period of time only because of the fact that you requested——

Mr. DECHERT. No, he had seen it ever since the Congress had seen it. The short time was the time within which to comment.

Mr. FELDMAN. The short time was the time before Congress got it?

Mr. DECHERT. No, sir. This bill reported on to the Bureau of the Budget before it came over here on April 2. It had been seen in a preliminary form; it was reported on.

Mr. FELDMAN. I am addressing myself to that period, not to the time it came over here. I am going back now to before April 2. Isn't that when the 24-hour period took place?

Mr. DECHERT. No, sir; the 24-hour period you are talking about the 24 hours Mr. Roy Johnson appeared before the Johnson committee. I am not sure it is 24 hours.

Mr. JOHNSON. I am sorry, Counselor. There are two 24 hours. The 24 hours I referred to was that for circulation of this within the Pentagon.

Mr. FELDMAN. Can you give us dates while you are talking?

Mr. DECHERT. I can tell you this. It was referred to the Department of Defense by the Bureau of the Budget on Thursday, March 27, and Mr. Quarles made a report for the Department of Defense on Monday, April 1. That is a short period.

Mr. JOHNSON. That is the period I am talking about.

Mr. FELDMAN. So, it was not after April 2; it was before April 2 before the bill came to Congress. It was in that period then that you had only 24 hours within which to make your comments. In fact, it was between March 27 and April 1. Is that not so?

Mr. JOHNSON. There was a 24-hour period. Yes, 24 hours within that period.

Mr. FELDMAN. Did you examine the bill carefully at that time?

Mr. JOHNSON. As carefully as one could under the pressure of business.

Mr. FELDMAN. That was the time you wrote the letter in reporting to Mr. Quarles on the bill?

Mr. JOHNSON. That's right. Well, the letter was addressed to the person soliciting all comments. We have the letter in our file and I wish I had brought it over. I did not realize the line of questioning

here but I am quite sure that comments were asked by counsel's office who was coordinating the comments for Secretary Quarles.

So my letter was undoubtedly addressed to the General Counsel's office.

Mr. FELDMAN. Could we have that letter placed in the record?

Mr. JOHNSON. I will be glad to.

Mr. DECHERT. I am not sure, sir; we will have to consult. This is the kind of thing that is not ordinarily released. It is purely preliminary. In the process of preparing legislation, customarily the great many reports from a great many people are not released because they are purely advisory in nature. It is like comments that committee members would write the chairman if the chairman asked them how to proceed next.

I do not think I can commit the Department of Defense on this, and neither can Mr. Johnson; I can investigate the matter, but I think this is the kind of thing which in the ordinary conduct of business you can't give out, such as comments between members of the Supreme Court before they write their final opinion.

Mr. BROOKS. It merely supports what he says so it should be identical with his testimony.

Mr. DECHERT. It is identical. It was addressed to me, I have seen it. But you can see why this kind of thing, in the nature of things, you cannot give out and still conduct business, because in the case of Mr. Johnson it might be perfectly all right, but another person might make a foolish suggestion. To give out these purely advisory reports might cause people to be unwilling to make any suggestions, because then the report might be brought out in the open.

It may be possible to shorten this whole procedure a good deal. Mr. Johnson has language on the two items that have been mostly under discussion, which language is satisfactory to the executive department as a whole, although it has not finally gone through the ordinary reporting processes.

I cannot commit the whole executive department to this exact language, but I believe confidently it will be approved, having talked to the persons in charge of policy decisions.

Mr. FELDMAN. Is it different from your testimony before this committee when you appeared?

Mr. JOHNSON. Yes, sir.

Mr. FELDMAN. Then I think we should have that language in the record. Would you state it?

Mr. FORD. May I ask, Mr. Chairman, if we have copies of it or will there be copies available?

Mr. BROOKS. We have no copies here.

Mr. DECHERT. It was written in longhand on the way over, after various telephone calls.

It begins on page 2 of the printed bill. I will try not to interrupt again but I will say what was intended. It was intended to carry out what Mr. Quarles said on May 7 before this committee. On the second page of his statement he quoted the statement of policy on page 2, line 4. He actually read a long sentence which begins with the words "The Congress" and ends with the words "in which case the agency may cooperate with, or on behalf of, the Department of Defense."

Then he went on and said in substance that it is "my interpretation of this language that it means that the Department of Defense will be in control of the military aspects." The language Mr. Johnson is about to read is intended to buttress what Mr. Quarles said before your committee on May 7 in this regard.

Mr. JOHNSON. Starting with line 4, lines 4, 5, 6, 7, and 8 remain the same.

Mr. FULTON. On page 2?

Mr. JOHNSON. On page 2. Then beginning line 9, "Operations in the case of which activities"—you can cross out the rest of the sentence that you now have and put new language. This new language is "in the case of which activities the Department of Defense shall be responsible."

Mr. MCDONOUGH. Down to the period on line 10?

Mr. JOHNSON. That is correct. Strike out the whole balance of the sentence.

Mr. BROOKS. Strike out from the word "which" on line 9, the balance of the sentence, which would take you through to the phrase "The Department of Defense" and the period.

Mr. JOHNSON. So then it would read:

> Except insofar as such activities may be peculiar to, or primarily associated with, weapons systems or military operations, in the case of which activity the Department of Defense will be responsible.

Mr. FELDMAN. That leads to this question. What activity, in your opinion, under this language would be of a peaceful nature and over which a new agency devoted to peacetime space research and development would have jurisdiction?

Mr. JOHNSON. Programs that are primarily civil include unmanned space flights to obtain scientific data, such as vertical probes, lunar and interplanetary probes, scientific satellites with associated data acquisition and analysis. I quote from the document that we are working on with NACA.

Mr. FELDMAN. Isn't that as vague as the language in the statute itself?

Mr. JOHNSON. This language must be, I think, vague at this point because we don't know the science out there and what we need to explore.

Mr. FELDMAN. Supposing there is a difference of opinion. Say that you are no longer with ARPA and whoever is at the head of NASA is no longer there and can't agree. What happens?

Mr. JOHNSON. The reconciliation under the terms of the instructions of the President would come to his adviser in the White House. At the moment I would presume he would get his advice from Dr. Killian.

Mr. FELDMAN. Dr. Killian, in turn, would have to make an investigation, a rather detailed investigation, as to the nature of that scientific project; is that not so?

Mr. JOHNSON. That is correct, sir.

Mr. FELDMAN. He would have to have in his employ a staff which would be able to determine that. Isn't that so?

Mr. JOHNSON. That might not necessarily be true. That depends on the capability of the man in that advising spot. If his background were such over a long period of time in this field that he did not need other technical advice he could make that decision personally.

Mr. FELDMAN. He could make the decision; there is no question about that. But, if it was something that involved cosmic rays and he did not know much about that field, could he make that decision then?

Mr. JOHNSON. Obviously not. I think the President would have to have this capability in one or more people to answer your question. It may be more than one.

Mr. FELDMAN. That would be a sort of agency in itself. Is that not so?

Dr. YORK. Am I to testify later or can I interrupt now?

Mr. KEATING. Will it be helpful to have him interrupt at this point?

Mr. FELDMAN. I have no objections to Dr. York answering any questions.

Dr. YORK. The President's adviser on science and technology is also Chairman of the present Science Advisory Committee and on the President's Science Advisory Committee there will always be people who will understand the sort of question you raise. I am a member of that, myself. In fact, I am on the subpanel on space.

Mr. FELDMAN. That is right. So you really have an agency on top of an agency. Is that not so?

Dr. YORK. Well, it is really different from most agencies. I guess that is right.

Mr. KEATING. This Advisory Committee is not in any way an operating agency. It is just a committee which advises the scientific adviser to the President?

Dr. YORK. Yes. It is called the President's Science Advisory Committee.

Mr. BROOKS. Is that set up by statute or by Executive order?

Dr. YORK. By Executive order, I am sure.

Mr. BROOKS. Mr. Johnson, you referred to your recommendation for more representation by the Defense Department. Whom did you recommend for the Defense Department?

Mr. JOHNSON. The language which I understand the Executive is willing to consider is on page 3, line 20, to substitute for "No more than eight," the word "nine" and to include three representatives from the Department of Defense.

Mr. FELDMAN. You say no more than——

Mr. JOHNSON. It says "nine members of the Board shall be designated from appropriate departments."

Mr. FELDMAN. It starts with the word "nine."

Mr. JOHNSON. Yes.

Mr. DECHERT. This is the second of the two things which I can assure you will be agreed to and which Mr. Johnson is glad to have done.

Mr. FULTON. Actually then, on this explanation, there is no contradiction in the testimony before the Johnson committee of the Department of Defense.

Mr. DECHERT. That is right.

Mr. FORD. May I ask how the language would read as now stipulated or proposed?

Mr. DECHERT. On page 3, beginning line 20, you strike our the word "no more than eight" and substitute the single word "nine."

On line 23 you strike out the word "one" and substitute "three." So it reads:

> Nine of the members of the Board shall be designated from appropriate departments or agencies of the Government of the United States, including at least three who shall be from the Department of Defense.

Mr. BROOKS. Members of the Committee, you have heard the second quorum call. What is the pleasure of the committee? I would suggest that we adjourn for 45 minutes and meet back here in 45 minutes.

Mr. MARTIN. If you don't want to come back, use my room 18 for the rest of the afternoon.

(Discussion off the record).

Mr. BROOKS. We will meet in 45 minutes in room 18.

Mr. JOHNSON. We have a mission plane standing by for 4 o'clock departure.

Mr. BROOKS. Can you advise them to make it 5 because it will take us 45 minutes for this rollcall. No question about it.

Mr. KEATING. It is the second call. We might be through in half an hour.

Mr. FULTON. Now that we have cleared up an apparent contradiction, why is it not possible to submit those for the record? Let the counsel submit you the questions.

Mr. FELDMAN. I think I have to get the answers. Let me tell you why. We want to get the record printed as quickly as we can because we are going into executive session tomorrow.

Mr. FORD. Why don't you stay here, George, and ask the questions.

Mr. JOHNSON. That will be better for me.

Mr. BROOKS. The committee will adjourn. In the meantime counsel can ask his questions. I will be right back as soon as I can.

(Brief recess.)

The CHAIRMAN. What was your language before the committee?

Mr. JOHNSON. The language I submitted before the committee, I tried to make clear, was one way to do it. Since that time after consultations through counsel with the Executive Office, I have come to agree to this modification which is acceptable to the Executive Office. This is a change in my position from previous testimony.

The CHAIRMAN. I will not necessarily say a change. Reconciliation probably.

Mr. JOHNSON. Yes, reconciliation would be better.

The CHAIRMAN. You also had some doubts about whether you had the authority to go into research under the language of the bill. What are your views on that now?

Mr. JOHNSON. I believe that research is permissible under this language to the degree that it is associated with military operations and to the degree that we are permitted now to go into research in any other area of science.

The CHAIRMAN. I just wanted to get your views. I remember at the time you were somewhat concerned as to whether the language would permit going into the research part.

Where was the other language that Mr. Johnson suggested?

Mr. FELDMAN. Here it is.

The CHAIRMAN. "In support of" or "presume." We discussed that word "presume" and something along that line was determined. Is that right?

Mr. JOHNSON. That's right.

The CHAIRMAN. Have you made any other suggested amendments to the Senate committee?

Mr. JOHNSON. No, sir. I did not recommend specific language to the Senate committee.

The CHAIRMAN. Have you any other suggested amendments?

Mr. JOHNSON. Yes, sir, on page 3, the designation of the Board, I understand the Executive has agreed also to changing on line 20 "No more than eight" to "nine."

(Discussion off the record.)

Mr. JOHNSON. I do not presume what Secretary McElroy would recommend here but that might not necessarily follow the three services. It could well be that he would recommend the Director of Research and Engineering, the Director of ARPA, and the Air Force.

The CHAIRMAN. I understand. I felt that language of this kind was much more preferred than providing that each one of the services shall be on the Board if they said not less than three.

This language has been cleared by whom?

Mr. JOHNSON. The Executive.

Mr. DECHERT. I have cleared it with the President's office. While it has not been cleared completely through the Government I can assure you that this will go through.

Mr. JOHNSON. Both language changes.

The CHAIRMAN. Any other suggestions?

Mr. JOHNSON. No, sir. Mr. Chairman, at this point in the interrogation regarding these changes I would like to affirmatively state that with these changes this legislation is satisfactory to me.

The CHAIRMAN. That is, the Department of Defense.

Mr. JOHNSON. To me as Director of the Advanced Research Projects Agency.

Mr. DECHERT. I can say it is satisfactory to the Department of Defense as a whole.

The CHAIRMAN. The bill as introduced is what you have addressed yourself to. The one thing that has concerned me is that word "except".

(Discussion off the record.)

The CHAIRMAN. Let me ask your opinion on this language, which has not been acted upon. Nothing has been done by the committee as yet. We are going to sit in executive session tomorrow afternoon:

> The Congress declares that the activities described in paragraph 1 shall be directed by a civilian agency which shall exercise control over aeronautical and space research and development sponsored by the United States and you shall act in full cooperation with (a) the Department of Defense insofar as such activities are peculiar to, or primarily associated with, weapons systems, military operations or the defense of the United States—

this other language can be put in there—

> (b) And the Atomic Energy Commission insofar as such activities * * *

The other language is what relates to the Defense Department. What would be your view?

Dr. YORK. What does that mean? Does that mean that the civilian agency is in charge of the program?

The CHAIRMAN. No (reading):

shall be directed by a civilian agency which shall exercise control over aeronautical and space research and development sponsored by the United States and who shall act in full cooperation with (a) the Department of Defense insofar as such activities are peculiar to or primarily associated with weapons systems.

Dr. YORK. What does that mean? It sounds as though they are in charge but they are supposed to cooperate with us. Space is a place and not a program.

The CHAIRMAN (reading):

In the case of which activities the Department of Defense will be responsible—

assuming that language will be adopted by the committee.

Dr. YORK. You were going to put that language in at the end?

The CHAIRMAN. Yes. I mean, assuming the committee acts on that language. I am assuming that the language is adopted. They say already we are going beyond the language of the original bill introduced along the lines of your proposed amendment made in the public hearings before the committee by adding "or the defense of the United States", which is all embracing.

Mr. JOHNSON. Sir, could that be read again?

The CHAIRMAN (reading):

The Congress declares that the activities described in paragraph 1 shall be directed by a civilian agency which will exercise control over aeronautical and space research and development sponsored by the United States and who shall act in full cooperation with, (a) the Department of Defense insofar as such activities are peculiar to, or primarily associated with, weapons systems, military operations—

then if you add this language, "in the case of which activity the Department of Defense shall be responsible"—assuming that language is added.

Dr. YORK. With that added it makes good sense to me. The point is that space is a place and not a program. In this country I do not think we consider that the ocean belongs to the Maritime Commission and the Navy has to get permission from the Maritime Commission to operate there.

The same way with space, if the Department of Defense wants to put up reconnaisance satellites I don't see why the civilian agency should have anything to say about it. The reconnaisance satellites are for military purposes, they are flying through space and operate in space but it seems to me they are military from start to finish.

Mr. FELDMAN. But you want constant liaison between the two?

Dr. YORK. If the civilian agency has some good ideas, actually in the short run these military programs, in fact both the civil and the military programs are in the Department of Defense. The civil agency has to come to the Department of Defense. All the ideas are in the Department of Defense at the present time.

The CHAIRMAN. How about the international aspect of it?

Dr. YORK. There I think it is easier for the international groups to work with the National Academy or with the civil agency or the Department of Defense.

The CHAIRMAN. What about the State Department?

Dr. YORK. I suppose they have to work through the State Department.

The CHAIRMAN. I can see that there are some programs they may not have to refer to the State Department, but I can see certainly,

where it relates to international and foreign affairs, that it would be unwise if they did not or if we did not provide for it.

Dr. YORK. I think those words you have on this little sheet of paper are awfully important with this rewritten that way.

The CHAIRMAN. Why do you think it is important?

Dr. YORK. If you didn't have those in there, it says the civil agencies are in charge and they are supposed to cooperate with us. It sounds as though if we wanted a reconnaisance satellite we would establish a requirement and then ask them to cooperate by putting one up. Those other words now say they are responsible for the military programs. Without those words then it just says they are supposed to cooperate fully.

Admiral CLARK. Or does it say we are responsible for the cooperation.

The CHAIRMAN. Do you think the language of the bill—"with weapons systems and military operations,"—with this additional language will it cover other activities of the Department of Defense? Are there other activities outside of weapons systems and military operations?

Dr. YORK. There is the research leading to them.

The CHAIRMAN. Are there other tactical activities?

Dr. YORK. What else would there be? We have to cooperate with the Space Agency rather than vice versa because we have all the vehicles.

Mr. DECHERT. May I say a word? I think the Department of Defense and the administration would be entirely ready, and perhaps glad to change the word "should" to "shall"—one of the two suggestions. As to the other, however, if I caught it correctly, you were going to include "or the defense of the United States" as an enlargement of the expression "weapons systems or military operations."

The CHAIRMAN. Some people have been talking about that.

Mr. DECHERT. It is my understanding that the President does not want to go beyond what he said in his message, through fear that if we go beyond, it will look as if we are trying to take this away from civilian control. He has tried to emphasize in the message that this is to be civilian, to the extent it is not directly military. Those words "defense of the United States" are very elastic words. Therefore I believe that the administration wants to keep the expression of the Department of Defense participation in the exact words that the President used on page 4 of his message, which are "weapons systems and military operations."

Mr. Johnson has indicated that the research leading up to weapons system and military operations is necessarily part of those systems and operations themselves.

The CHAIRMAN. I would think so. But on the other hand I suggested to Mr. Johnson that we could put words in there—"do research activities"—or some words to that effect. I thought the authority contained in here carried with it the power to accomplish whatever was necessary. On the other hand, if you wanted it spelled out, I have no objection. You don't like the language, "the defense of the United States."

Mr. DECHERT. I am afraid it is too broad. You remember, before we got into World War II we set up the "Defense Commission", which covered a tremendous territory. As I understand the administration's point of view, there is fear that if we use such very broad words as that,

it will be thrown in our teeth that we are not really setting up a civilian agency, but we are just pretending to do so; we are really giving it all to the military. That result we do not want to bring about.

Admiral CLARK. I should say another objection to it is that what we do in the line of defense here may well be in defense of the free world, not just United States. and we could go further in this program and spell out international cooperation.

The CHAIRMAN. I know, but we could not put in the bill anything in connection with defense of the free world.

Admiral CLARK. No, sir. That is why I say we should leave out any area regarding defense.

Dr. YORK. I thought the words you used were such as to give the NASA more authority over what we were doing rather than less. That is the way it sounded to me without the additional words on that sheet. I thought this was in connection with the authority of the NASA that you were putting them in the defense of the United States.

The CHAIRMAN (reading):

> Insofar as such activities are peculiar to or primarily associated with weapons systems, military operations or the defense.

Well, there may be something to that.

Dr. YORK. It sounded to me as if you were putting the defense space effort into the NASA.

The CHAIRMAN. With this language "In the case of which activities the Department of Defense shall be responsible"——

Dr. YORK. That puts it back to us again.

Mr. JOHNSON. In answer to the question, on thinking it over, I believe the language you are recommending is less clear than the language I am recommending now with the changes I understand the Executive are approving.

Mr. FELDMAN. I don't think there is any less clarity.

Dr. YORK. Does your language allow the Department of Defense to go ahead all on its own and put up reconnaissance and early warning satellites and defend them?

Mr. JOHNSON. This word "cooperate" I am quite sure will be misconstrued to imply that you have the responsibility but cooperate is imperative and there may be situations—there is one right now—with which I don't think a civilian agency could cooperate.

Mr. FELDMAN. Have you attempted to cooperate with a civilian agency?

Mr. JOHNSON. There can be a single military problem that might make cooperation under some circumstances quite difficult, in the broader sense.

The CHAIRMAN. In other words, if this proposed language is in either one of the bills, either one will be satisfactory?

Dr. YORK. Where it says "In which case the Department of Defense will be responsible."

Mr. JOHNSON. If you are asking me the question the answer is "No, sir." The language you are discussing as a possibility for that bill, I think, is less clear than the language which I have recommended to you.

The CHAIRMAN. I say if this language is approved as recommended—

in the case of which activities the Department of Defense shall be responsible * * *.

Mr. FELDMAN. Could I ask a question?

The CHAIRMAN. Certainly.

Mr. FELDMAN. Would you interpret this language you have just suggested as giving you the exclusive authority to decide without any cooperation or without cooperating with the new agency what is military?

Mr. JOHNSON. Yes, sir.

Dr. YORK. Doesn't the House Appropriations Committee decide that when it makes the appropriations?

Mr. FELDMAN. Let us not get into that. We are writing the legislation now. We might as well make the legislation as clear as we can. If you fall under this you can make your own decision as to what is military and what is not——

The CHAIRMAN. We might as well put a bill out and put it in military control.

Mr. DECHERT. Isn't that subject to the fact that both these agencies will be part of the executive department and if those in the civilian agency believed that the military agency had made the wrong decision they always have the right to appeal to the President on it. I think the President is the ultimate arbiter if there is a disagreement.

The CHAIRMAN. I agree with you but Mr. Johnson gave a different answer. Which is it now?

Mr. DECHERT. I think his answer was that the preliminary decision will be the decision of ARPA, but as I say, there must always be an appeal in this kind of thing. Therefore I think Mr. Johnson's answer is properly supplemented by what I say.

The CHAIRMAN. What you said gives us a little different picture than Mr. Johnson's direct answer, which I appreciate. According to his answer, the military has the complete control. We know there will be no difficulty, and as I see it, there should not be. There are certain things which are distinctly military. There might be some things that are peaceful by nature today and years later, when we have a more peaceful world, they might extend themselves further. But there will be some twilight zone decisions to make. It is in that area that these questions arise. According to you there is an honest difference. According to Mr. Johnson the Space Agency could not raise the question.

Mr. DECHERT. I think he did not mean to indicate that. I don't mean to try to read his thoughts. But you asked him pointblank who would make the initial decision. You did not say "initial," but I think that is what he understood. I think that the Department of Defense would make the initial decision that a particular matter is within its jurisdiction, if it believes that it is primarily a military matter.

On the other hand, I think it is clear as long as the statute does not say that the military shall have the final and conclusive view on this that it must necessarily be decided, as other things, are decided within the executive department.

That means in case of disagreement you carry it to the President.

The CHAIRMAN. I can understand that now. Does that represent your views, Mr. Johnson, with this clarification?

Mr. JOHNSON. I agree with counsel completely.

Dr. YORK. Also in the next few years, in fact right now, those definitions will be written out by common law. We are already agreeing with NASA on what they should do and what we should do, what are joint and what should be cooperative. We have four programs—military, civil, joint, and cooperative.

The CHAIRMAN. Following your observation then, there will be no objection if the committee decides to put a provision in the bill providing that where there is a dispute, the President should make the decision.

Mr. DECHERT. If you are asking me alone I think that is all right, and I see no reason why others should not agree with me. That is the practice today.

Dr. YORK. Yes, that is what we are doing right now on the space program.

The CHAIRMAN. The President might designate someone to look into the matter.

Mr. DECHERT. This, sir, is exactly what is being done in another field, the responsibilities in space with respect to use of the airspace by civilian and military airplanes.

The CHAIRMAN. You see, when we are writing a law we have to project our minds into the future as far as we can, to try to see what the law of natural consequences might be in this. No act is final. We know from the past that there has been a clash of personalities and interest, and so forth. I will not go into that because that is human. I found out enough about that in 1954 on the Riehlman committee. I am not saying that in any criticism.

For example, suppose this language was included in the bill:

> If the Department of Defense concludes that any requested action or proposed action or failure to act on the part of the Commission is adverse to the responsibilities of the Department of Defense, or the Commission concludes that any request for action, proposed action or failure to act on the part of the Department of Defense is adverse to the responsibility of the Commission, and the Commission and the Department of Defense are unable to reach agreement with respect thereto, either the Commission or the Secretary of Defense may refer the matter to the President, whose decision shall be final.

Dr. YORK. I would like to get back to this point, that I think the frame of reference that people are thinking in is not quite right, that space is a program and not a place to do certain things. The civil agency is going to have a budget, they are going to ask to do certain things which are approved or not approved and they can go ahead with them according to whether they are approved or not.

The military will also be asked to do certain things in space. It will be approved or disapproved. It can go ahead with what is approved for it and the civilian agency will go ahead with what is approved for it. We are doing the things which will mainly support defense. The civilian agency will have a budget of a certain size. They will do things which mainly support the civil space program. If we both do something there might be a small amount of duplication but those are the kinds of things that we iron out in a liaison committee.

I don't know why one should be so careful in dividing up the program. We will both operate in space but we will not run into each other or these satellites are not going to collide. There is plenty of room up there for both programs. What we want to do is recon-

naissance, early warning. We want to investigate man in space. So does the civilian agency. We are going to do that jointly.

The CHAIRMAN. I think you should do it jointly. I just read some language. What is your objection to that?

Mr. DECHERT. Mr. Johnson has said as far as he is concerned that seems appropriate and I for the Department of Defense as a whole say that the procedure is appropriate.

I cannot speak beyond that general statement. I will be glad to investigate it.

It seems to me the procedure we now adopt in many fields is perfectly natural.

The CHAIRMAN. I think we have cleared the air a lot.

Mr. MARTIN. All intents are the same.

The CHAIRMAN. Everyone on this committee is a practical man. We realize what the world is, we know what the dangers are, and we know what the situation is. We recognize the urgency of defense, not as a national objective but rather the necessity of defense while other national objectives of an affirmative nature are pursued. We try to bring them into effect as far as possible, such as disarmament.

Mr. FELDMAN. I want to call Mr. Johnson's attention to his testimony before the Senate committee in which he said that "both civilian and military agencies should be permitted to go their independent roads if they so desire."

Is that view consistent with your statement?

Is that view consistent with the statement to the Senate committee that "this Nation cannot afford the luxury of duplication in space research"?

Mr. JOHNSON. To answer that question I do not believe that you would necessarily have duplication by allowing both agencies to go independent routes. I think you would have parallel work at worst, and I did say in my statement to one of these committees that I did not think the scientific work very often was duplicated.

Scientists do not like to go down identical paths of another scientist.

Mr. FELDMAN. We are not talking of scientific work exclusively now. But when you say that you see no harm in parallel work, it could be in duplication when it is parallel. Is that not so?

Mr. JOHNSON. It could be under certain circumstances; yes. I think you could say there is some duplication in aircraft design between the military airplane design and the civilian airplane design.

Mr. MARTIN. It is not likely to be very large with the Appropriations Committee supervising the expenditure.

Dr. YORK. If there are responsible people in the agencies, if there is cosmic-ray data available that is of use in the space program, we are going to be husbanding our resources and not duplicate that research.

Mr. FELDMAN. That will be accomplished through constant liaison. Is that not so?

Dr. YORK. Yes. I do think some programs will be so expensive that they ought to be joint. We are already planning to do that. The "man-in-space" program will cost a lot of money.

Mr. JOHNSON. Before you came to this meeting, Mr. Chairman, I discussed the document that we are now ready to submit for approval to the Secretary of Defense and the Chairman of the National Advisory Committee for Aeronautics which spells out in detail this

working relationship to provide minimum duplication between the two agencies.

We are in complete agreement for 1959 on what to do and how to do it.

(Discussion off the record.)

Mr. FELDMAN. Should not some person or agency plan and coordinate all aspects of space research in order to prevent gaps and to insure effective cooperation?

Mr. JOHNSON. Definitely not, sir. I think that would be the most tragic thing that could happen to this country.

Dr. YORK. You do not do that with maritime. The maritime and Navy go on and both use the ocean.

Mr. FELDMAN. What I am thinking of is what happened at Pearl Harbor where the Army and the Navy were supposed to act in cooperation with each other and they did not. I suppose they did get together there but there was no requirement that they do that at all. The result was that when the Army got the information about the Japanese planes coming there was no one to give it to the Navy.

Dr. YORK. Of course, the purpose of ARPA is to make sure that the Army, Navy, and Air Force are together on the space program.

Mr. FELDMAN. Why not the civilian agency? Why not have the same cooperation with them?

Dr. YORK. If their purpose is primarily to explore space and planets, and so on, all we need is the information they get. If they are not getting the information that is necessary for defense we get it ourselves. That is why I think these things can be almost independent.

Mr. FELDMAN. They can be almost independent and then we will run into another Pearl Harbor.

Dr. YORK. I don't see how there could be another Pearl Harbor in a case like this.

Mr. FELDMAN. I am talking of organization now. We know this, that the Atomic Energy Commission has problems with the military; they have constant liaison, and problems are ironed out. How many of these difficulties do get to the President at all when there is a dispute between them as to what is military and what belongs to the Atomic Energy Commission? If you look into the history of AEC, practically nothing has been referred to the President. The reason is that there is constant liaison. The right hand knows what the left hand is doing constantly.

Dr. YORK. We are back on the liaison question. We already are having plenty of liaison. We meet with NACA almost every day.

Mr. FELDMAN. Supposing your successor decides not to do that.

Dr. YORK. He would be acting irresponsibly.

Mr. JOHNSON. Sir, may I interject here? Does this question imply that you would set up one commission to rule all space 1 inch above the ground and coordinate all production of all aircraft, civil and military, and all transport and all travel in air, wherever it is?

Mr. FELDMAN. I am not setting forth what the agency will do. I am trying to get enough information of what it should do.

Mr. JOHNSON. I am trying to understand what your language meant.

Mr. FELDMAN. What language?

Mr. JOHNSON. The question you just asked us for the record here.

Mr. FELDMAN. I am just trying to get your views on what kind of

cooperation we should have. You say that each agency should be independent. At least Dr. York says that.

Dr. YORK. Yes.

Mr. FELDMAN. And whether or not they will have liaison between them will be a matter of discretion.

Dr. YORK. I did not want to get mixed up in the argument about liaison. I think liaison is fine whether it is in the law or not.

Mr. FELDMAN. It is all part of the same ball of wax.

Dr. YORK. Right. What is worrying me is if this liaison committee was made independent of the two organizations and sort of sitting above them.

Mr. FELDMAN. How does the liaison committee in the Atomic Energy Commission function with the military?

Dr. YORK. It is not above the Department of Defense or the Atomic Energy Commission. It is a channel of information. That kind of liaison committee I am all for.

Mr. MARTIN. I understand these gentlemen have a very important conference at 4 o'clock. Is that true?

Mr. JOHNSON. We have a military mission to fly to Cambridge at 4 o'clock today with some 15 or 20 men.

Mr. FELDMAN. I just want to ask one more question. In other words, when the President now is talking of a national space program—National Space Agency—what you are saying instead is that we should have one for the Department of Defense and one for peacetime.

Dr. YORK. I say space is a place and not a program at all. It is a place where you have different programs.

Mr. FELDMAN. Then the President's message does not mean what it says, in other words.

Mr. BROOKS. Mr. Johnson, on page 3 you refer to the membership of the Board—National Aeronautics and Space Board. That will come up further in the bill any number of times. I have done a good deal of work with the Reserves and I was wondering if you would classify a reservist on inactive duty as a member of the Government, a civilian or a civilian member of the Defense Department?

If that is the case, then the question of emolument comes in. I think he is civilian unless he is on active duty. I think that ought to be cleared up. If the President should appoint a member of the Reserve establishment just because he has a commission in the Reserves, it would not make many ineligible or not make many a representative of the Defense Department.

Mr. JOHNSON. I think that is correct, sir.

The CHAIRMAN. You say this language has been cleared in the executive branch?

Mr. DECHERT. Yes, sir.

The CHAIRMAN. Who?

Mr. DECHERT. Mr. Gerald Morgan, counsel to the President.

The CHAIRMAN. "Nine members of the Board shall be designated." That shifts it from the 8 to the 9.

Mr. DECHERT. The previous draft says "not more than eight." This now has nine.

Mr. FELDMAN. Thus, he could have one for that matter because it said not more than eight. Now this clarifies that.

Mr. BROOKS. That makes a very important change. It creates Government control.

Mr. JOHNSON. That is right.

The CHAIRMAN. Who passed on that?

Mr. DECHERT. Mr. Morgan. Mr. Johnson explained that it might be civilians from the Department of Defense. It says at least three. It could be more than three.

Mr. BROOKS. It would not be a Reserve officer?

Mr. DECHERT. I think this matter of Reserve officer is covered by the statutes.

The CHAIRMAN. You still keep "the Chairman of the Board shall be designated by the Department from among the civilians."

Mr. DECHERT. There is no change in that.

The CHAIRMAN. What caused the change from "eight" to "nine"?

Mr. JOHNSON. This is a Government agency, it will therefore have a majority vote by Government representatives.

Mr. FELDMAN. Was it not also because of the fact that that point was stressed before the Senate committee?

Mr. JOHNSON. I think that has been discussed there, too; yes, sir.

Mr. FELDMAN. When you say "disputes should be resolved by the President", you really mean the Presidency, is that not so?

Mr. JOHNSON. The Executive Office; yes.

Mr. FELDMAN. Won't the decisions be made in practice by some lower echelon, perhaps by the Bureau of the Budget?

Mr. JOHNSON. The Bureau of the Budget is a member of the Executive Office. He could indicate that the Bureau of the Budget could make the decision for him.

The CHAIRMAN. Any further questions?

Mr. BROOKS. Mr. Johnson, are you going to put a copy of your agreed arrangement in the record? Is it available for this record? I mean that which you have in your hand now.

Mr. JOHNSON. This document?

Mr. BROOKS. Yes.

Mr. JOHNSON. When this document has been approved and signed by the Secretary of Defense and Chairman of the National Advisory Committee for Aeronautics I shall be very glad to have this as part of the record. I cannot now because it has not been approved yet. This is a working paper.

Mr. FELDMAN. I have one further question, Dr. York. Getting back to that point about you having only 24 hours within which to look at the President's bill, isn't it a fact that you are a member of the National Advisory Committee?

Dr. YORK. The President's Science Advisory Committee.

Mr. FELDMAN. That is the Killian committee; is that not so?

Dr. YORK. Yes.

Mr. FELDMAN. Weren't you apprised of the bill before?

Dr. YORK. I saw a number of versions of it as it went along; yes; but that was before I was in the Defense Department. After I went over there I had the same situation as Mr. Johnson, namely, that I did not see the final version of the bill when it came over until he saw it. I did see working papers as we went along.

Mr. FELDMAN. How much time did you spend in connection with the bill?

Dr. YORK. I saw various and sundry working papers on it, I would say, off and on for about a month before it came over to the Department of Defense.

Mr. FELDMAN. So that it was not new to you, in other words?

Dr. YORK. No; it was not new, although this particular version was new.

Mr. FELDMAN. Do you mean the final bill as it was sent to you?

Dr. YORK. Yes; the one that came over about the 27th of March.

Mr. FELDMAN. But you had seen the bill grow?

Dr. YORK. I had seen it grow.

Mr. FELDMAN. Would you say that it went through your Department at least on a motorcycle?

Mr. YORK. You mean in the Killian committee?

Mr. FELDMAN. Yes.

Mr. YORK. No, I don't think it went through on a motorcycle. It was in and out of the office for something like a month. As I say, these were working papers with lots of different versions. It was not until it came over to the Department of Defense that I knew which one of the many possible versions it was finally going to be. On the other hand it was no surprise to me that NASA was to be built on NACA.

I sat in on many of the arguments about whether or not the Director should report to the President and all that sort of thing.

The CHAIRMAN. Any further questions?

Thank you very much, gentlemen. We will make this a part of the public record.

(Whereupon, at 3:55 p. m., Monday, May 12, 1958, the committee adjourned, subject to the call of the Chair.)

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